

Ens, Transactions, American Geophysical Union

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Vol. 65, No. 19, Pages 345-352

Tectonophysics

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Volcanology

8659 Volumelogy
IGNIMATITS OF THE EASTERN SHAKE RIVER PLAID:
EVIDENCE FOR HAJOR CALDELA-FORNING EMPTIONS
Liss A. HoBronem (Hawall Icetitute of Camphyelog, 2529)
Gorras Md., Boundells, Sl 96822), David J. Dobetty,
and William P. Lessen
The mestern Sacks River Plain is a predominantly
chapter occurant and Logone to the present-day

The mestern Sanks Edver Plain is a predominantly chyclicle proviace, analogous to the present-day Yellowstone Plates volcanic field but older and further wolved. The widespread Quateresty basaicic lawas that now blankst the eastern Sanks Siver Plaie oppaar to have excepted efter major thyclitic mattricy means and rayresent lass than 202 of the total volume of the plaio. Three major (spinbrits sheets, comparable is magnitude to those of the Yellowstone Fleisen field, have been correlated on both sides of the mestern Sanks Siver Plain from the Arco end Ponstelle areas to sargins of the Yellowstone Plateau. This field of 4.3-5.3-Ne-old ignisbrites is referred to herain se the Helse volcanic field. Spidies of factor changes and lateral variations in the three major ignisbrites of the Saise Hidd prevalt ideal fication of related calderes which eya now buried beaseth the ignisbrites overlap compositionally, dark was derived from an isotopically distinct magnetic and services of the suppositionally, as the was derived income in lactopically distinct magnetic and services of the suppositionally, as the was derived income in lactopically distinct magnetic and services of the supposition of coursel material.

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A New Interdisciplinary Focus on Precipitation Research

Committee on Precipitation, AGU Hydrology Section

Introduction

In the Hydrology Section of the American Geophysical Union, a new Committee on Preinitation was formed in fall 1982 consisting of nine members from the fields of hydrology, atmospheric sciences, statistics, and mathematics. The objective in bringing together these scientists from different disciplines was to collectively address important problems and directions in precipitation research that are of central interest to the long-range derelopment of hydrologic science. It is somewhat true but true that advances in the stochastic modeling of rainfull require corresponding advances in the understanding of physical processes which produce precipitation. Consequently, a working dialogue between bydrologists and atmospheric physicists In formulating and addressing research plans seems quite appropriate. In this same spirit, advances in the stochastic modeling of rainfall require advances in mathematical and statistical techniques. Issues pertinent to major untolved problems and research directions in understanding, modeling, and predicting of precipitation in space and time were extensively discussed among the committee mem-

bers and are summarized in this article. Hydrologic science deals with water in all of its forms: in the atmosphere, in lakes, in oceans, in streams, and underground. However, either directly or indirectly, precipitation is the source of many varied effects. For example, streamflows, infiltration into soils. and groundwater recharge and evaporation are all directly related to the precipitation patterns peculiar to a region. Hydrologic dudies are converned with predictions on time scales ranging from a few days to a few reeks, months, seasons, years, or even from several decades to a few centuries. The spatial scales of central interest in hydrology are formally dictated by the dimensions of river basins, which can range from a few to several thousand aquare kiloniciers. On these spacetime scales, precipitation exhibits significant vaciability. To model this variability, hydrologists and meteorologists have traditionally employed somewhat ad hoc probabilistic and statistical techniques. Mareover, these techniques have been developed primarily for nodeling temporal fluctuations in precipitation at fixed points in space such as at a rain gauge [see, e.g., Waynire and Gupta, 19B1; Ketz, 1983]. Owing to the diversity of climatic processes in different geographic regions and to the lack of detailed understanding of the physical processes producing rainfall on the scales of hydrologic interest, probabilistic and statistical modeling have been largely confined to a case by case analysis without a basis in the physics of precinitation and the ubserved structure of precipitation systems. In this article we discuss three broad issues

related to future research on precipitation. first, because physical/dynamical processes interact on different scales, it seems impossible within the foreseeable state of the art to ormulate a single model that includes all of the processes operating at these scales. Thus, a major problem in modeling precipitation is appropriately linking the stochastic descripons at the unresolved scales with the deterministic physical/dynamical descriptions at the resolved scales. The "innresolved scale" refers to scales in which the fluctuations about the average values of certain parameters and physical variables are significant enough to require description in some form. Second, although physical/dynamical considerations are expected to play an important role in adrances in stochastic modeling of precipitation. the problems of parameter estimation and statistical inference are not expected to be solved by appealing only to precipitation physics. Moreover, new statistical techniques emain to be developed for the class of stochastic models likely to emerge in this area, particularly for stochastic descriptions of space-time rainfall. Third, the issues conrerning measurement of precipitation using rain gauges, radar, and satellite need unich research in relation to precipitation modeling and interence problems. In the opinion of this committee, significant advances in pretipitation research will require the concerted and combined efforts of scientists from a variety of disciplines. Some recommendations will be made regarding ways to reach this ob-

Spatial/Temporal Scales

Precipitation is one of the most difficult metelogical que ntities to forecast because it is the product of a complex combination of dynamic, thermodynamic, and cloud microphyskal processes. An important emphasis in me-

teorology has been placed on the identification of meteorological phenomena, including precipitation patterns, in terms of the interactions of physical proresses operating on a variety of scales in time and space. Several different systems of terminologies have been used to describe these scales; Orlanski's [1975] terminology has been most widely adopted

and is used in this article. Because the scales of the physical/dynamical proresses that produce and distribute precipitation constitute a scale continuum, foi both theoretical and practical reasons a model describing or predicting precipitation can have only limited temporal and spatial resolution. Atmospheric processes at the unresolved scales have to be treated statistically because the information needed to describe these processes is not available or because the physical processes themselves lead to inherent fluctustions at such scales. In this latter case, owing to the nonlinear and turbulent nature of atmospheric flow, even processes resolved by a model have only limited ranges of predictability in the deterministic sense. Beyond the limits of predictability, only statistical treatment of the processes is possible. A major task in precipitation modeling is to determine the statistical structure of the unresolved processes and to couple this statistical structure to the physics/dynamics of the processes at the resolved scales.

The hypothesis that the statistical fluctuations at smaller unresolved scales are linked with the dynamics at larger resolved scales appears physically tenable because of the strong control and feedback mechanisms at different scales among the processes produc-ing and distributing precipitation. Observations also appear to support this hypothesis. For example, studies n1 meso-B scale 120-200 km precipitation features over the tropical Atlantic have shown that their behavior is modulated by large-scale air motions in the lorm of macro-β (2,000–10,000 km) or synoptic scale waves in the middle troposphere [see Houze and Bens, 1981]. These precipitation systems usually occur in a preferred region of the large-scale waves (in and ahead of the wave trough). Such large-scale dynamical control over the behavior of smaller scale precipitatinn patterns holds not only in the tropics but also in the middle latitude: (Horse and Hobbs, 1982]. This deterministic aspect of the occurrence of precipitation at the macroβ scale is accompanied by an unrertainty in the exact position in the occurrence of smaller-scale precipitation patterns within a large meso-a scale (200-2,000 km) area. This unrertainty in the occurrence, intensity, variability, and duration in space and time of the precipitation patterns makes a crucial difference in responses of hydrologic basins to pre-

Stochastic-Dynamic Modeling

A major discovery of the last 10 years has been the recognition of the importance of or-ganization of precipitation patterns at the meso-β scale. In nn unstable environment, cunutionimbus clouds at the meso-y scale (2-20 km) are often organized into characteristic nieso-β scale precipitation patterns. The internal structure of these precipitation pattems includes a leading edge of intense convective rells, about 25 km in width and 200 km in length. This leading edge is frequently arc-shaped. Rainfall rates in this portion of the precipitation pattern are highly variable (10-100 mm hour"). Behind the leading edge lies a stratiform precipitation region in which a meso-\(\beta \) scale ares of rainfall is characterized by rather steady, light to moderate precipitation rates (1-10 num hour1).

In a stable environment, band-shaped areas of moderate to heavy precipitation at the meso-β scale, called rainbands, are often embedded in a large area of stratiform clouds the meso- α or macro- β scale. These rainbands are typically 5-50 km in width and 100-200 km in length. The dynamical and microphysical processes involved in the for-mation of rainbands are not yet understood. A more detailed description of the precipitation and cloud structures at the various scales can be found in the review papers by Houze [1981] and House and Hobbs [1982].

The organization of the precipitation fields at the meso-β scale described above can be qualitatively incorporated into stochastic repesentations of the ground level rainfall intensity fields. These representations can then be exploited for investigating various statisti-cal features of these fields (e.g., covariances, extremes, and crossing properties). Even though this line of research was initiated by LeCata [1961] more than 2 decades ago, little progress was made in this direction, partly because of mathematical difficulties encountered in obtaining analytical results. Some recent findings, however, call for optimism in the future. For example, Waynire et al. [1984] have demonstrated that a stochastic representadon of a precipitation field which takes into

account the observed organization in extra-tropical cyclonic storms at the meso-β scale admits a spectral representation which satis-fies Taylor's hypothesis concerning fluid tur-bulence for time intervals smaller than the mean life time of convective rainfall cells embedded inside a rainband. Beyond this time interval, Taylor's hypothesis is no longer valid. These features were observed and reported a decade ago by Zawadzki [1973].

The stochastic models of precipitation in-

tensity fields being explored in hydrology

stiggest rertain natural mathematical prob-

lems. These models are typically point ran-

dom field models (see Waymire et al. [1981],

for example). For such representations the calculation of exact probabilities in explicit form is difficult, if not impossible. Also from physical viewpoint, die interest generally lies in describing the evolution of certain averages of the rainfall intensity field at suitably chosen scales rather than the evolution of the rainfall intensity field itself. As a solution to this problem, one is usturally led to the prob lem of obtaining asymptotic estimates which would apply to evolution of rainfall averages in space and time. This scheme of research is in the same spirit as, fur example, the use of the central limit theorem to obtain asymptoti estimates for probabilities associated with sums of random variables when the calculation of exact probabilities is all but impossible and physically the objective is to study the evolution of "space-time averages" [see, e.g., Wax, 1954]. The asymptotic investigations in the context of precipitation fields would also require that careful attention he given to scales in both snace and time as well as to statistical dependencies so that links between statistical/dynamical descriptions at different scales may be properly understood. The links between different scales are also the ingredients of the problems confronting atmospheric scientists. For example, recently it has been suggested that cloud and precipitation fields constitute a turbulence contituum at spatial scales ranging from 1 km to 10° km in horizonial extent [see, e.g., Lovejoy, 1982]. Using satellite and radar data, these investigators reported a power law relationship for the cloud and precipitation pattern perimeters and areas which seem to hold over these spatial scales, thereby suggesting the existence of a communous turbulence field changing from a three-dimensional structure at small scales to a two-dimensional structure at the large scales. If such a continuous structure indeed exists it would impose a global constraint on the point random lield models of precipitation fields being explored in hydrology [sec. e.g., Waymere et al., 1984]. However, the dynamic compling between processes at different scales seems to be the key to the physical unterstanding of such a structure.

The stochastic models of space-time rainfall discussed above are developed directly from and exclude the natural evolution of these

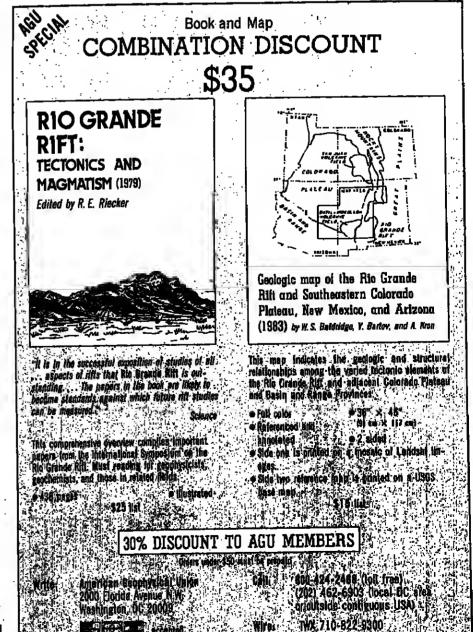
dynamics. An important direction for future research in this area would be to understand the dynamic eoupling between the meso-β scale fluctuations and the time-averaged dynamical behavior of atmospherie processes at larger scales. Recent research exemplifying this direction addresses the problem of understanding the way in which the thermal gradients in a wide spread stratiform cloud can produre bandlike features near a front [Leary et al., 1983]. Further studies of this type should help provide an enhanced under-standing of the role of dynamics in precipitation fluctuations. One of the central problems in modeling the atmosphere has been the statistical treatment of weather elements which produce precipitation. Owing to the release of latent heat of condensation, precipitation producing processes represent an energy source for the atmosphere. A rigorous description of these processes seems essential for the improvement of weather prediction. Some attempts have been made to study the statistical ensemble properties of clouds and their effects on the larger scale weather sys-tems [Arakawa and Schubert, 1974; Cho, 1978]. These studies have emphasized the dynamic and thermodynamic interactions between processes at different scales and are still in an early stage of development. Further research on control and feedback mechanisms between various scales of precipitation systems, including important boundary effects (e.g., orography, roughness discontinuities, and soil mois-ture) is clearly needed.

fields dictated by the laws of physics and

Statistical Inference

Although dynamics is expected to play an important role in the stochastic modeling of precipitation, it is unreasonable to expect that it will be possible to specify all the parameters in stochastic models safely from dynamics. Therefore, the status of parameter estimation and hypothesis testing pracedures for sto-chastic rainfall models becomes a critical problem. Past trends show that model developinent has outpaced the development of inference procedures. This problem is particularly acute for space-time rainfall models. The only classes of space-time models for which satisfactory inference procedures are available are those that can be specified by (simple) spatial and temporal autocovariance functions. Moreover, judging from the curent situation concerning interence procedures for the models representing the tempor ral evolution of rainfall, there is a significant uced for rapid improvement in inference procedures for more complex space-time models. However, many procedures applicable to temporal rainfall models are tied to the ordering of the time parameter. This state of affairs seriously limits the common route of developing higher dimensional results as gen

Article (cont. on p. 380)



The Oceanography Report portunities in the coastal ocean, as will work-



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Editor: Arnold L. Gordon, Lamont-Dohetty Geo-logical Obsesvatory, Palisades, NY 10964 (telephone 914-359-2900, ext. 325].

Farewell Remarks by **Chris Mooers**

For 6 years it has been my privilege and deasure to serve the Ocean Sciences Section as air elected ollicer. First as Secretary, then as President-Elect, and finally, as President. The tacd theme I leave pursued through these rears has been to help the Ocean Sciences Cammunity awaken to opportunities within AGU, to "liex its mus-des" as a large, strong, rapidly growing seg-ment of AGU, and to become involved in using AGU's programmatic resources for the benefit of the sitellectual and professional development of the ocean sciences. (Our seclion is the second largest of 10 sections and may become the largest within several years, if the present relative rate of growth is sus-

tained.) Like any large organization, AGU

has inertia; however, we have fearned that it

the initiatives of activist. And we have unly

is Hexible and yields to and, in fact, supports

syratched the surface. In recent years, the Ocean Sciences community has continued to grow and mature. Much of its scientific communications has involved reporting results of the first two generations of "large science" programs in AGU (and other) meetings and juurnols, while not neglecting advances still to be gained by "small science." Major process, especially on the mesoscale, and regional studies have yielded not only major scientific results but also the community expertise and confidence to proceed to higher levels of quantitative science, to larger-scale and longer-term prob-lems, and to multidisciplinary studies. With declining funding levels and aging facilities, the field has become more competitive, just as it is poised to move into what may be its "prime." In this situation, some of us thought it was important to move toward a higher level ol'emessiveness, professionalism, and sense of community. One avenue of initiative open to us in community building was a stronger role in the programs of AGU.

Let me summarize some of the intitiatives taken. The Oceanngraphy Section was renamed the Ocean Sciences Section to recognize the breatth of our interest and our continuing transition to a quantitative, predictive science. The Oceanography Report, edited by Arnold Gostlon and issued on a monthly basis in Eos has been a great success as a vehicle AGL policy circles for an Ocean Sciences Bulletin if and when we are ready for it. Under A. D. Kirwan's, and then Jim O'Brien's, editorial leadership, a component Journal of Geophysical Research dedicated to the oceans has been luought into existence. The recently published Careers in Oceanography booklet, produced under Chales Hollister's leadership, has given 11s an exciting, straight-talking recrulting psimphlet for the first time. We now have an Ocean Sciences Education Secretary, Peter Brewer, to answer inquiries from young people. Ocean Sciences butcheons have become fixtures at all national meetings. They are used for building a sense of cummanity through discussion of Section and AGU issues; for presentation of a major, informal talk by a community leader, usually from Washington, as an unofficial exercise in accountability; and for presentation of the recently Instituted Ocean Science Awards, given for outstanding and sustained contributions to the community through service, research, leadership, and so forth. A campaign has continued to welcome biological oceanographers at AGU meetings and as AGU members. Part and parcel with this has been the continued series of joint, experimental meet-

ings with ASLO, and now other societies, being with other nations in elecebring their ocean science capabilities for EEZ resource ginning with San Antonio (convened by Worth Nowlin and Dick Eppley) in February 1982, cnlocation of ASLO and AGU meetings in December 1982, the Ocean Sciences Meeting 1984 in New Orleans in January (convened by John Apel and Dick Barber), and the upcoming integrated ASLO/Ocean Sciences Section Program (planned by Wolfgang and Pat Kremer) at the December 1984 AGU Meeting. We have now settled on a biennial Ocean Sciences Meeting.

In recent years, our hardworking, creative

ogram eliairmen for AGU national meet-

Dave Cuteliin, and Bob Molinari. Many oth-

ers have served on program committees, as session chairmen, on ad hoc committees of

the Section, and on the standing committees

of the AGU per se. The point to be empha-

sized is that the Union and the Section are

very much participatory entities and that the Ocean Sciences community can be strength-

ened by even broader participation. Please let the new Ocean Sciences President, Joe Reid,

know if you want to be involved and in what

"standardize" section bylaws is the establish-

mittee, consisting of three elected section offi-

cers and up to five others. Under my "reign,"

besides Joe Reid, Peter Brewer, and me, the

O'Brien, John Apel, Harmon Craig, and Jim

gic planning for the Section and effectively

extends the leadership. Together with the Geodesy Section and the President of AGU.

we have pressed for the issue of a national

olicy statement on the releasability of GEO.

SAT data. On a Union-wide basis, the role of

the sections in the selection of AGU Fellows

Sciences Section now has an ad hoc AGU Fel-

lows Nominating Committee, chaired by the

President-Elect, Consequently, we have pre-

been much more successful in the election of

Ocean Sciences Section members as AGU Fel-

lows. (There is still a need for more members

monograph series in coastal and estuarine regimes has been initiated, with the first vol-

Much more potential remains to be tapped

ences Section has not exploited much the top-

munications. We have not been fully active in

all-Union sessions (e.g., Frantiers of Geophys-

scientific meetings, the quality and coherence

proved. (We have made improvements there

meeting rooms and the organization of pre-

such as, Geodesy, Hydrology, and Atmo-

spheric Sciences. AGU can help us in orga-

cruitment efforts. The Ocean Sciences Bulle-

tin idea, modeled after the Bulletin of the AMS

come forward as the inaugural editor. There

and Physics Today, is waiting for someone to

is also room for more specialty journals. Fi-

nally, the possibility exists to organize an Ocean Sciences society within AGU if there is

There are exciting times ahead for the

ocean sciences, and the Ocean Sciences Sec-

lead them. For example, owing to the imper-atives of the scientific agenda for global

ocean circulation, marine ecosystem, biogeo-

other studies, of technological opportunities

provided by super computers, microprinces-

sors, new sensor systems, future ocean satel-

moored and drifting bonys, and ships-of-op-portunity, of scientific opportunities provided

by new understanding and models, and of

programmatic needs associated with the mis-

ons of the new National Ocean Service and the soon-to-be revitalized Naval Oceanogra-

phy Program, the dawning of global synoptic oceaningraphy is at hand. The community will need help in adjusting to the sociological

shock of working in real-time, and the Ocean

and foster the "revolution," and the concomi-

tant educational needs and employment op-

portunities that the new industry of opera-

tional oceanography will bring. If oceanogra-phers can commit themselves to work in real-

communities will accrue in the form of coop-

benefits include the ability to conduct up-to-

date quality control of data acquisition, adap-dive sampling strategies, and onboard scien-tific analyses. Similarly, the prospective large

scale exploration for resource management

(exploitation and conservation) of our EEZ.

will provide new scientific challenges and op-

eration and resources to achieve otherwise unobtainable goals in global ocean studies of climate variability and related topics. Other

time, benefits from the operational

Sciences Section can help to communicate

dremical transport, benthic province, and

tion needs to anticipate them, and to help

eient need, interest, consensus, and lead-

nizing more effective graduate student re-

lesignated thematic sessions.) More could be

with joint sessions with other sections:

ics.) With more participation in organizing

of our talk and poster sessions can be in-

brough the aggressive pursual of better

ical meetings mechanism for scientific com-

to nominate colleagues.) Last, a new AGU

within AGU, For example, the Ocean Sci-

mes to appear within a year.

scuted better ducumented cases and have

has been greatly strengthened. The Ocean

Baker. This Executive Committee does strate-

nembers have been Arnold Gordon, Jim

ment of an Ocean Sciences Executive Com-

Part of the AGU-wide effort to update and

have been Clayton Paulson, John Bane,

Chris Mooers u outgoing President, AGU Ocean Sciences Section.

management. For all of this, oceanographers

will need to communicate with other science

Again, the Ocean Sciences Section (or Socie-

ty) can serve to help traverse these new from-

disciplines, engineers, and technologists.

News & Announcements

Physics of Shallow **Estuaries and Bays**

The objective of the symposium is to pro-mote the exchange of information on recent developments in estuarine physics between physical oceanographers and coastal engi-neers. Emphasis will be on shallow estuaries and bays twell-mixed and partially mixed

The symposium stresses results of field and laboratory measurements and the formulation of the governing equations and bound-ary conditions as opposed to numerical tech-niques. Both well-mixed and partially mixed estuaries are included. The following topics will be covered: (1) large-scale transport processes (mixing); (2) tide and wind-induced residual flow; (3) small-scale turbulence; (4) suspended sediment transport; and (5) exchange ween ocean and estuary/bay.

The symposium will be held at the Rosen-stiel School of Marine and Atmospheric Science, University of Miami, Florida. The dates of the symposium, August 29, 30, and 31, 1984, were selected to allow participants to combine attendance of the symposium with the 19th International Conference on Coastal Engineering (ICEE) to be held in Housion. Texas, September 3-7, 1984. The symposium is cosponsored by the Coastal Engineering Research Council of the American Society al Civil Engineers and the Rosenstiel School of Marine and Atmospheric Science.

For additional information, registration. etc., write: Physics of Shallow Estuaries and Bays, do Division of Ocean Engineering and Applied Marine Science, RSMAS, University Miami, 4600 Rickenbacker Causeway, Miami, FL 33149 (telephone 305-361-41610.

Meetings

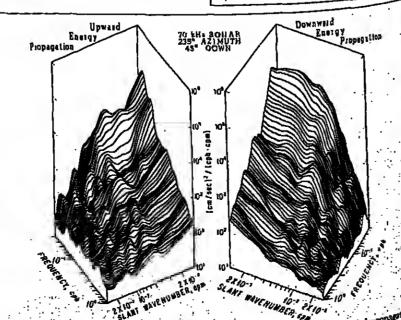
New Directions in

Internal Wave and

Collaboration of oceanographers across traditional boundaries always results in exciting new insights into the complex processes which govern oceanic motions. Such cultaburation was evident at the second fantual 'Alia Huliko'a Hawaiian Winter Workshop, held hi Honolulu, Hawaii, January 18-20, 1984. This year's topic was Internal Gravity Waves and Small-Scale Turbulence. Participants from Europe, Canada, and the United States reviewed recent developments and jampused intriguing studies in the kinematics and

Microstructure Research

Fig. 1. Seasonal variability of the internal wave continuous. The data points re-resent the high frequency (0.1-2.0 cpl horizontal kinetic energy from 13 moor ings in the North Atlantic over a 10-year period. The tmenings are all substract. The instrument depths are 114-306 m and the heatings range from 10° 50°N dynamics of internal waves, line structure, and 12°-71°W. The error bars are plus and microstructure. Here we summarize the and minus one standard deviation (courte phlights of the meeting and identify some of the emerging trends, all subject to the parsy of M. Briscoef.



-frequency spectrum of the upward and downward internal wave energy. The spectra were measured with a Doppler solvar off the definition of the spectral wave field in the definition of the internal wave field in the definition of the defini range from 80 to 600 in and over a period of 18 days (cutilities of R. Plikel).

Internal Waves

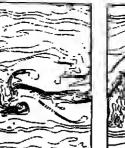
Internal waves are viewed as an important link in the overall or eating energy cascade from the large scales of generation to the small scides of dissipation. Although the donmant somees and shoks for internal waver hace mit been identified, the following concent is generally accepted: Energy energies internal wave held at large scales and cascarles down to small scales by nonlinear wavewave interactions. When the shear reaches 2 critical value, the waves break and generate small-scale turbulence and microstructure Ar microscales energy is dissipated by molecular processes. Research that led to this picture his been dominated by the comept of a noiversal internal wave spectrum, an idea intoduced over a decade ago by Ganett and Must [1972]. During the workshop, the concept of a universal spectrum was challenged, whereas the link between internal waves and microstructure was substantiated.

"Universal" Spectrum. Observed species usually lit the "aniversal" spectrum to within a factor of 3 for frequencies significantly above the inertial and less an in the near-iner tial band [Www.ch, 1917ti; Briscoe; Levine]. (Nate: Unilated references refer to talk gir en at the workshop. These talks will be published in the proceedings. Copies may be ob tained from Peter Möller, University of Hawaii, Department of Oceanography, 1000 Pope Road, Honodalu, HI 96822.) This means that there is an order of magnitude variation in the spectral levels. These variations are likely the dynamical signatures of the sources, sinks, and internal transfer of the internal wave field. It is these dynamical leatures that have become the object of inteud wave research.

The deviations of the internal wavefeld from the universal lurus exhibit definite paterns. Energy in the near-inertial frequency band varies in response to storms and to me soscale features (Il'Astro), as well as geographically and with depth (Fn. 1981). The energy in the higher frequency continuum varies seasonally and geographically (Brises, Levine, and Figure It and near topographi fratures (Erisksett). Clear patterns exist in its data; explanation of their dynamics is a dallenge to future research.

New unasurement techniques like Dopple sincers reveal botal spectra that are not stumble but show an integrilar structure with

rulges and shoulders (Bukel and Figure 2) Nunlinear Internetions. Nunlinear intersetions among internal waves have primally been analyzed by using the weak tesonanto teraction approach. Hetailed calculations but







DENSITY

Fig. 3. Overturning of density surfaces in a twn-dimensional simulation of strongly interacting internal waves. The domain represents a vertical plane, the lines isopycnals. The Richardson immber of the flow is about 0.7. The frames are separated by about half a buoyancy period (courtesy of G. Holloway).

been made by using this technique, and an inertial range theory has emerged similar to the one in turbulence theory [McComes and Maller, 1981]: Nonlinear interactions cascade energy clown die spectrum from the generauon to the dissipation scale. The level of the energy spectrum adjusts itself to the energy flux through the spectrum. The downscale cascade is associated with an energy transfer from high to low frequencies, somewhat upposite to conventional wisdom. The appropri ateness of the weak resonant interaction approach for small-scale waves has been quesuoned because interaction times are often much shorter than the periods of the waves [Holloway, 1980].

Now, nonlinear interactions are investigated by two new methods: numerical integration of the Navier-Stokes equations in two dimensions (Holloway and Figure 3) and Mon-te-Carlo simulation of the Eikonal equations

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Cover. The photograph shows a Roman scallop shell mosaic dading back to about A.D. 130–150. The border is a Hellinisde rave pattern, found in the earliest classical mosaics, those of about 400 B.C. at Olyntheus. The wave pattern closely reembles the billows observed in Kelvinlemholtz shear flow instability between wo fluids of different densities. The instaillty is thought to be the cause for internal wave breaking and mixing in the ocean. The photograph is reproduced with the permission of the Director of the Vendamium Museum at St. Albans, U.K. Photo submitted by Eric D'Asaro and Peter Müller. See meeting report in this is-sue of The Oceanography Report entitled "New Directions in Internal Wave and Microstructure Research.")

that describe the evolution of a small-scale wave in a background wave held (Henyey). Their preliminary calculations show unexpected and exciting results: an upward mass flux (mixing) at low wave numbers in Holloway's calculation and preferred layers of breaking "patches" in the Eikonal ap-proach. Unlike the weak interaction calculauous, the new approaches produce spacetime results that will eventually allow direct comparison with experimental data. Such comparison certainly will stimulate a greater interaction between theoretical and observational oceanographers.

Sources and Sinks

Numerous sources and sinks have been proposed for the internal wave field [see, e.g., Olbers, 1983]. Observationally, the situa uon miglu be summarized as "a little hit of evidence for everything" (Briscoe). No domi-nam generation or dissipation mechanism has been identified, although some progress is occuring on some mechanisms.

Theoretical and observational evidence is emerging that the wind generates near-inertial frequency waves at large vertical scales (D'Asaru) and that internal waves and the mesoscale flow strongly interact (Waison).

Classically, it has been assumed that the internal wave held dissipates its energy predominantly in the interior of the ocean, through small-scale turbulence. Calculations (Eriksett) indicate, however, that the loss of internal wave energy in a sloping boundary might be substantial and could be the major energy sink of internal waves. Significant sinks of energy also may occur in critical laywithin fronts or edities | Kunze and Sandford. 1984). These losses would be representated at particular locations in the ocean and not spread uniformly throughout its volume.

Current Fine Structure

Existing velocity and temperature measurements clearly show that linear internal waves alone cannot explain all of the observed structure within the internal wave frequence band [Mäller et al., 1978]. In particular, the culterence between current meters as a function of vertical separation drops rapidly within the first few meters and then decays more showly on a scale of many tens of theters. The rapid drop is traditionally attributed to current fine structure. At frequencies well above inertial frequency, curvent line structure has an energy density comparable to that of internal wave motions. The kinematical and dynamical character of current fine structure is unclear. The traditional view is that it represenis internal wave currents concentrated at small vertical scales because of the fine structure in the Brunt-Väisälä profile. A different view (Müller) holds that current fine structure is an entirely different type of motion with well-defined, distinct dynamics. Unlike internal wares, this "vortical mode" of motion Riley et al., 1981] carries potential vorticity. Current fine structure might, hence, be the small-scale realization of the same mode that represents quasigeostropic flows at mesos-

tical" motions is also a punblem in the atmosphere. In meterology, the "vortical" mode is alled "stratified two-dimensional (2-D) turbulence." The observed atmospheric mesoscale spectra are roughly consistent with theones of upscale inertial ranges in stratified 2-D turbulence (Lilly).

The implications of the existence of the

vortical mode for the dynamics have not yet been explored, but we expect the vortical ntode to be intimately connected and intertwined with the internal gravity mode of mo-tion (Holloway). A distinction between the internal gravity and vortical mode of motion requires the measurement of vortidity on small scales, a measurement that to date has not been possible because of lack of sultable instruments; however, a "vorticity meter" is now being developed by Sanford (personal communication, 1984), so that such distinction might soon become possible.

Small-Scala Turbulence

If double diffusive effects are ignored, mail-scale turbulence measurements are almost always discussed within the following,

now classical, framework: Estimates of oceanic mixing rates can be made from relocity and temperature measurements that resolve the small scales un which molecular dissipation occors. Measurements of the Richardson number on the meter scale commonly show values of the order of 1 or less, suggesting that shear instability is a major mechanism for mixing. Assuming that the shear respons ble for the small values of the Richardson number is due to internal wayes, dissipatiun dricen by shear instability becomes an energy sink for the internal wave field. Accordingly, the rate of mixing and the properties of the internal wave field are related. If this link were understand, the rate of mixing could be parameterized in terms of the energy sources and environmental parameters of the internal

wace field.

Studies of the relationship between smallscale turbulence and the internal wave field clearly require measurements of both the purbulence, using microstructure instruments, and the internal wave shear and density helds, using larger scale measurements. Existing evidence suggests that the internal wave field is highly random, so many measurements are required. Instrument systems capa hle of repeated measurements of both microstructure and internal wave scales have only recently become available (Gregg, Osbotti) and are limited to use it the upper few houdred meters. Simulianeous measurements of the internal wave spectrum and microstructure over periods long enough for significan changes in the internal wave lield to occur are not yet available. It is, therefore, not sur prising that the research in this held is still exploratory.

If, as hypothesized, small-scale turbulence s driven by the internal wave field, its structime should reflect me structure of the wave held. Observationally, this issue is complicated by the possibility of turbulence caused by double diffusion which is ignored here. Nevertheless, several promising links between the internal wave field and occanic turbulence are emerging.

Patchiness. Measurements of small-scale turbulence generally show that the imitividual mixing events are not randomly distributed. but concentrated into "patches" of high activity. These "patches" vary in size from centimeters to 10-20 m (Gregg, Dugan, Osburn, and Figure 4], with the smaller patches being more common.

Two theoretical approaches based on internal waves predict such a structure: Calculations of the terrical distribution of the Richardson number, Ri, made assuming a Garren and Mank internal wave spectrum, and Gaussian statistics (Desaubies). If a turbulen patch is assumed to occur whenever Ri < 1/4, a range of "patch" sizes, comparable to that observed, is computed. A more detailed comparison with the observed "patch" statistics would be interesting. Eikonal ealculations,

internal wave spectrum, have also been used to model the spatial distribution of small-scale torbulence (Flenyey). It is assumed that an individual wave breaks when it reaches a sufficiently high wave number. One such calculation shows the persistent clustering of the breaking events at a particular level, suggesting the formation of a turbulent "patch." This calculation suggests that it may be possible to formulate general criteria for the location of such patches as a function of the background shear field. Recent experimental work suggests a link

which trace individual waves in a background

between the larger patches and near-inertial frequency shear. One such patch, which persisted for nearly a day, occurred at the same depth as a small inertial jet (Gregg).

Shear Statistics. The universal internal wave spectra have dominantly been energy spectra and have not accurately described the statistics of the shear and clensity gradient fields, particularly on scales smaller than 10 m. Such a description is needed if accurate models of the link between microstructure and internal waves are to be developed. A "unicersal" shear spectrum has been proposed by Gargett et al. [1981], but it is not complete. There is still uncertainty as to whether the shear at 10 m scales is ilonninanty inertial, as at larger scales (D'Asaro) or inantly high frequency (Pinkel). This particular question is complicated by Doppshifting of small-scale celocity features. Basic descriptive work is needed on the shear and density gradient distribution, spectrally, spaially, and temporally.

Kelviu-Helmholtz Billows. A variety of inge-nious arguments developed in the last decade allow K, the vertical diffusivity for mass, to be estimated from microstructure naranieters; however, a clear picture of the three-dimensioned structure and evolution of these mixing events has not yet emerged. Generally, mixing is envisioned as being caused by Kelvin-Heliofichtz billows. The structure of these bilkows was very nicely depicted by the artist of the Roman scallon shell mosaic shown on the cover. These billows have been extensively studied in the laboratory and have been observed at one location in the upper ocean (11'oods, 1968). The extrapolation of laboratory strilles to the ocean may be difficult, thre to side wall effects in the laboratory stodies (Thorpe). A variety of other strattersl shear flow instabilities with structures distinct from Kelvin-Hehnholtz billows, such as wave breaking and critical layer absorption, have been observed in the laboratory Hillioner. 1973) and may also occur in the ocean. Frobulence research in other helds has benefitted greatly from flow visualization studies that aim to identify the dominant structures of the tarbatent flow. Once the structures of a flow here been identified in this way they can asoally be identified in point measurement. It seems likely that similar studies using dye or high-frequency acoustics would likewise increase our understanding of oceanic turbulence.

On the theoretical side, the nonlinear stability of stratified flows has been investigated by using a constrained energy method due to V. I. Arnol'd (Abarbanel). Applied to the customary parallel shear flow in the presence of stratification, one proves that the llow is nonlinearly stable for Richardson numbers greater than unity. The theoretically interesting regime is hence 1/4 < Ri < 1 where the flow is stable to infinitesimal perturbations, but may be unstable to finite pernurbations. Shear-generated turbidence in homogeneous fluids is being studied with new second-order closures. Employed in numerical models, these yield good predictions of the observed Reynolds stress censors evolving in strained and sheared wind tunnel flows (Gallagher).

Oceanography (cont. on p. 380)

TEMPERATURE CONTOUR DISTANCE km

Fig. 4. Patches of microstructure in a temperature section. In the shaded areas the microstructure activity is 30% above the mean. The lines represent isotherms. The data are from the Sargasso Sea and were obtained with a thermistor chain towed at a speed of about 250 cm s (courtesy of J. Dugan).

Oceanography (cont. from p. 379)

Parameterization

Many oceanographers prefer to study the large-scale motions of the ocean. These oceanographers regard internal waves and small-scale turbulence as suligrid-scale noise and ask for the parameterization of subgrid fluxes in terms of large-scale flow characteristics. They ask for eddy diffusion and viscosity coefficients. Here the state of affairs is still not satisfactory. Most work on parameterization has been concerned with the rettical diffusion coeffirient K_{ν} . A typical value of 0.1 cm2 s.1 seems not to be inconsistent with microstructure measurements and the kinematics and dynamics of internal waves (Garrett). A similar value is obtained when the observer large-scale hydrographic field is fitted by beta-spiral methods (Olbers) but that value Includes an artificial rontribution due to averaging of the data. Basic questions are still unanswered. For example, how much of the vertical mixing is done in the intedur of the ocean and how much is done in boundary layers? Does the value K, have a strong depth dependence? The miswers to these questions rnuld have dramatic implications. Changing the depth dependence of the dissipation rate changes the direction of the meridianal circulation in an advertive diffusive model of the thermulaline circulation (Gargett).

The momentum linxes are even less established. There are only sporty measurements.

Some of them imply significant eddy viscosity coefficients [e.g., Brown and Owens, 1981], but no coherent picture has emerged from the

Internal gravity waves and small-scale turlence are the motions by which the ocean mixes momentum and mass. The specific way in whirh this mixing is done has pronounted effects on geostrophir eddies and the general circulation. To understand these grander scales of motions, we must understand the smaller-scale mixing processes.

Internal wave researth is presently undergoing a transition from a dominantly kinematir study of spectral slopes to a dominantly dynamir study of sources, sinks, and internal fluxes. The link between internal waves and oceanic turbulence is becoming more apparent, and the glintmers of a dynamical understanding are emerging. The parameterization of the internal wave and unbulent fluxes, which is a major goal of these studies, has not yet been athieved.

microstructure and from a detailed rompari ginning of whirh was witnessed at the Hawai-ian Winter Workshop.

Conclusions and Trends

Further progress will come from simultaneous measurements of internal waves and son of experimental data with the results of numerical models. These experiments and studies require collaboration of oceanograpliers across specific areas of interest, a be-

Acknowledgments

The second 'Aha Huliko'a Hawaiian Winter Workshop on Internal Gravity Waves and Small-Scale Turbulence was supported by the Office of Naval Research. Hawaiian Institute of Geophysics rontribution 1483. We thank all the participants of the workshop for their valuable ideas (many of whirh have gone unacknowledged here), and for their permission to quote unpublished materials.

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Article (cont. from p. 377)

eralisations of lower dimensional results. From a hydrologic standpoint there is little doubt that temporal stochastic models will continue to be of importance in hydrobygir research, particularly for small med and urhan basins over which the spatial rariability in rainfall is not as appreciable. However, the inference procedures currently available for temporal unidels are only satisfactory for a hamfinl of cases, for example, Markov chains, Poisson process, and reurwal models. An important research direction in temporal modeling is to insestigate the suitability of different stochastic numbels as dictated by the time scales of interest te.g., hourly, daily). Furthernore, parameter estimation in such noulels needs to be addressed in relation to the availability of rainfall data on these time scales. It will be particularly important to address the issue of disaggregation/aggregation and the applicability of a prodel to time scales other than those for which the parameters are estimated. It seems that not much attention has been given to these important issues in precipitation research in the past.

Measurement of Precipitation

One limitation to the development of more accurate descriptions of the space-time structure of precipitation is the ability to measure preripitation. For space-time rainfall mudels, typical rain gauge networks seldom provide sufficiently detailed information for model testing. Ahhough point data from rain gauges have relatively high accuracy, though a gauge ratch error of "about 10%" is considered the norm for rainfall, in most locations the network of gauges is sparse in the sense that precipitation becomes uncorrelated in space over distances comparable to or less than the gauge spacing, at least during some types of events. The fine structure of precipi tation in time also is beyond the time sam-

pling interval of most rain gauge data. Remote sensing technologies, such as thuse provided by radar and satellites can help fill in the space-time sampling gaps, but remotely sensed measurements are much more tenuonsly related to precipitation than gauge measurements. A well-maiotained, well-colihrated radar can easily he in ecror by a factor of 2 or 3 in its preripitation estimates. Unusual atmospheric conditions can make obtaining quantitative estingates even more difficult. Satellite techniques also a hieve much better spatial coverage than gauges but generally at recluced accuracy.

In addition to degrees of accuracy and space-time coverage, remote sensing technologies differ from ganges in sampling characteristics. Gange values can be ceasonably treated as point values with a lairly simple erfor model; white muse, for example. In contrast, remotely sensed values represent a space-time average of the precipitation field, corrupted by a wide variety of sensor, transrulssbin, translation, and unvigation errors. While it seems possible to establish the error characteristics of rain gauges directly by conducting wintl monel tests and comparing results with highly accurate expetimental gauges, more suphisticated procedures are needed to infer the error structure of temotely sensed observations. The problems associated with the error structure of remotely sensed precipitation estimates seem to have received little attention thus far in preripita-

tion resenrch. The above issues rlearly suggest that rontinued efforts to improve the accuracy of remotely sensed precipitation estimation tedinologies and terhalques are acceed. A better grasp of the nature of errors in precipitation

measurements would be of consulerable value because of their direct relation to the problem of statistical inference and model verification procedures. In this respect it would be beneficial to employ the advances in precipitation modeling to address the issues of network design problems. These problems are romplex because of the need to address not only the sensor placement issues but also because of issues related to choosing a mix of sensors with different sampling characteris-tirs. Another important role that advances in precipitation modeling can play is in the problems associated with merging rain gauge raular, and satellite data. These areas clearly are in need of further comprehensive research. A related problem is the availability of precipitation data itself. Although the National Climatir Data Center maintains precipitation data from about 12,000 gauges, not all of these data are available in a timely fashion (i.e., there is quite a lag before much of the data are available).

Precipitation and "Operational" Hydrologic Forecasting

Operational hydrologic applications have a wide variety of needs for precipitation estimates and forecasis. For example, hydrologic design problems and real-time hydrologic forecasting produce distinrtly different reirements ou precipitation focecasts. Hydrologic forecasting involves time scales ranging from about an hour to a few days and requires quantitative precipitation forecasts based on current conditions. In hydrologic design the temporal resolution may be the same or ronsiderably longer (e.g., months or years), but the data period considered frequently extends to several decades.

Long-range hydrologic forecasting natural ly requires longer range precipitation fore-casts. Procedures exist which produce probaoilistic hydrologic forecasts for water supplyirrigation, riverine navigation, and hydropower applications with lead times from a week up to several months. Although these lead times exceed the capability of terhniques which produre (single valued) quantitative preriphation farecasts, improved rapability to forecast the precipitation regimes in n proba-hilistic sense would be of direct value in lungrange forecasting for the above applications as well as in hydrologic design.

overnents in hydrologic inrecast lead time (the difference in time between the time of the occurrence of the forecasted hydrolog phenomenon and the time when the fore cast is issued) and accuracy can be nebieved if reliable quantitative precipitation forecasts (QPF's) are uvailable for specific watersheds as input to the hydrologic furecast models. Unfortanitely, current QPF mulels and procedures generally do not provide sufficiently accurate values for direct input to hydrologic models, at least for forecast periods exceedhig an hour. Although current QPF products provided by the National Meteorological Center (NMC) provide generalized guidance in-Iornatiun whirh is very useful in roughly indicating rainfall amounts and incations of rainfall areas, they do not provide the detail and accuracy required for assigning QPF val-ues to individual watersheds. There is a need for mure direct incorporation of QPF information into hydrologic modeling and predicilon procedures. This is esperially important to the improvement of forecosts for small watersheds where the lag time between rainfall occurrences and outflow from the basin is

It is apparent that hydrologists are in a position to provide guidance on meteorological requirements for hydrologir forecasting. In this respect communication between hydrologists and meteorologists would be particularly useful in improving the hydrologir usefulness of short-term (e.g., 1 hour to 3 days) quantinative precipitation forecasts. A positive step in this direction is the assessment of operational quantitative precipitation forerasting proredures being prepared by the Office of Hydrology of the National Weather Service [Georgakahos and Hudlow, 1983]. Similarly, ong-term forerasts are intended in part for water resources applications, yet there appears to be little condination between hydrologists and meteorologists to ensure that the form and substance of forecasts roufness to the applications.

Final Remarks and Recommendations

In the above paragraphs we have attempted to bring out the scope of research directions in precipitation studies and indirate an imperative need to promote and undertake interdisciplinary research on precipitation. It is clear that in order to accomplish this objertive a strengthening of the mutual rooper-ation among hydrologists, meteorologists, atmospheric scientists, mathematicians, and statisticians is ralled for. We offer the following preliminary recommendations in order to initiate this undertaking.

A national STORM program is being orga-nized by the U.S. meteorological rounnumity. STORM, derived from "Stormscale Operational and Research Meteorology," is the acronym for the U.S. Mesoscale Meteorology Program designed to study mesoscale atmnspheric processes for improved short-range weather predictions. The need for improquantitative precipitation forecasts is identified as one of the key problem areas.

Three field experiments are being planned for the STORM program. The first of these experiments, called STORM Central, is to take place in the spring and summer of 1988 in the central United States from the Rorky Mountains to the east of the Mississippi Valley, and from the Culf of Mexico to the U.S .-Canadian border. The experiment will collect upper air and surface data with high spatial temporol resolutions for 120 days over a 2000 × 2000 knt area. It will provide a data set suitable for the study of precipitation processes and for the testing of precipitation models. No data sets with similar resolution and coverage have ever been collected. Many of these data can be used for hydrological

We therefore recommend that the hydrological community actively participate in the ning of the experiment and in the analysis of the experimental data for hydrological studies. For this purpose, immediate actions are needed, first, to coordinate the planning of a network for collecting hydrologic data on basins in the central United States (e.g., streamflows, groundwater levels, soil moisture, evaporation, and evapotranspiration) and, second, to provide input to the STORM Central planning team for coordinating the collection of these data in conjunction with

meteorologic data. In addition to the above, we would like to make the following recommendations: (1) that the Office of Hydrology of the NWS establish a working group to study the users' need for quantitative precipitation forecast; (2) that the National Climatic Data Center esablish a hydrometeorological data archive :

designed for applications to ranous hydrologiral modeling and data analysis problems. luding precipitation; (3) that 1-3 day symposia, workshops, or special sessions at AGUI AMS/ASA or other conferences are organized; (4) that AtiU publish monograph rontaining review papers; (5) that special is sue(s) of appropriate journal(s) addressing important recent developments in precipita tion are published; and (6) that research projects having strong interclisciplinary makeup are funded by NOAA/NSF/NASA/USGS and other agenries.

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Thunder Day Increase

A report issued by the Illinois State Water Survey concludes that annual values of thunder days for North America exhibited a general increase of about 15% from 1901 to 1945, followed by a general decrease of 10% from 1945 to 1980. A study of the variability of thunder days across North America showed a general decrease with time, particularly after 1940. A major finding of this study is that frequeucies of diunderstorms over areas as large as the North American continent show major long-term trends.

The report, "Temporal Distribution of Clobal Thunder Days," summarizes the resuits of a 1-year study by Stanley A. Change non, Jr., and Chin-Fei Hsu of the tempora variations of thunder-day records during 1901-1980 using quality weather rerords from weather stations scattered around the globe. A thunder day is rerorded when on or more peals of thunder are heard anytime during the 24-hour period from midnight to midnight, which is consistent with the defini tion of a thunderstorm used at first-order weather stations sinre 1897. They found mos stations in die northern hemisphere north of 45° latitude exhibited a general increase in thunder artivity from 1901 to 1980. The project was funded by the National Science

Data for the study was rollerted from 90 stations in North America and 131 stations elsewhere around the world. The stations in North America selected were those that had operated on a 24-hour basis for the period of 1901-1980. The data from most foreign stations had periods of rerord of only 30-50 years, which limited the investigations of treods in thunder days in areas outside of North America. The data were evaluated to check for shifts in thunder-day frequencies due to station reloration, for major disroutinuities between station averages and area averages, and for possible changes in thunder frequencies due to potential noise problems, such as might be caused by increased air trafhe near a station. These tests led to the conclusion that four stations (Atlanta, Ba.; Kansas City, Mo.; Portland, Maine; and Toroniu, Ont., Canada) had records that were incorred and so were not used. These tests were not applied to the foreign stations because of a lack of station histories.

Examination of the temporal distributions of thunderstonns was done in several ways, induding factor analysis and other statistical lests. The continent was first divided into four sectors with divisions at 10tt W longitude and 40° N latitude, and remporal distributions in early sector were determined. Analysis ronfirmed that there were major regional differences in temporal frequencies of thunder days arross North America. Ceneral increases in frequencies from 1901 to 1980 were found in the northwest and northeastem sectors. The southwest sertor frequenties generally increase in the first 45 years and

then rapidly descrased in the following 10 years. Relatively low frequenties were experienced from 1956 to 1980. The southeast scrfor exhibited little trend until 1930, followed by a general decrease until 1080. Stations with similar 5-year average values were classified into regions of similarity. This

classifiration method produced 14 regions in the United States and Canada, which themselves fell into two mojor regions. One was the northern United States and all of Canada, where all stations exhibited a general increase in thunder-day frequency, and the other was the southeastern third of the United States, which exhibited a major decrease in thunder-day frequencies after 1925. A norrow transition zone separated the two major regions.

The 14 regions in North America can be related to major climatic zones such as differ-

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enres in major air mass sources, particularly in summer, areas of cyrlogenesis, and location of major cyclone tracks, the southeastern United States, for which there was a major decrease in thunder-day frequency, is an area of major industrial development and pollution in the United States, and the decrease may or may not be related to possible manmade influences.

The report roncludes that the major temporal variations in thunder days were largely due to major shifts in the atmospheric circulation, reflected in the continental scale frequenries of cyclonic storms. Historical regional data on ryrlone frequencies in North America would be useful in identifying the regional crends found. Comparison of thunder days with actual thunderstorm durations and other measures of atmospheric electrifity are needed to help assess any temporal fluc-tuations in lightning discharge activity.

This news item was contributed by Steven D. Hilberg, Extension Services Coordinator, Illinois Stote Water Survey, Champaign, IL 61820.

MORP: Keeping Track of Meteorites

If one considers the level of significance frequently granted to observations of small portions of an individual meteorite sample, the question of sampling error arises. A project to answer this question has been underway in Canada for 9 years (1971-1983). The Meteorite Observation and Recovery Project, or, more simply MORP, is an observational network designed to evaluate the frequency of meteorite falls on the surface of the earth [see I. Halliday, A. T. Blarkwell, and A. A. Criftin, J. R. Astron. Soc. Con., 72, 15, 1978]. Other major networks for observation have been operative in the United States and Central Europe, Halliday, Blackwell, and Criffin reported recently on MORP results: "...the total mass deposited on the ground is 142 kg year1-1 in 106 km2. . .it is obvious that a very small portion of the potential harvest is ever located" | Science, 223, 1405-1407, 1984]. The actual numbers from the analysis are staggering. The normal recovery rate of meteorites per year in the world is no more than one or two dozen texchiling "fossil" merconites rerovered from the Antarctir glacial ice). The number of meteorite falls over the entire earth's surface is about 25,000 per year, according to the MORP analysis.

The basis of the analysis is photograph observation of fireballs in an area of clear sky. Meteors were observed by at least two camera stations at an altitude of at least 8°. The MORP results turned out to be an observation of 1.16 x 1010 km2 hours over the 9 year period. Analysis of the photographs were used to calculate masses and rategorize the meteors. Halliday et al. used as calibration, the observation and rerovery of the Innisfree fall [Meteorites, 16, 153, 1981].

Figures predicted by meteor sample mass give a clear picture of the sampling problem. In North America, the annual numbers of meteorite falls for total masses of 0.1, 1, and 10 kg per foll was 920, 1980, and 38. For the entire land area of the earth die annual numbers for the diree mass categories were 5800, 1200 and 240. Other calculations rould be niade to estimate the number of ore objects that survive the earth's atmosphere and rearh the surface. Further, the estimates could be extended to encompass the earth-moon system of the solar system. - PAIB

Research Roundtable

A blue-ribbon panel of government, university, and industry leaders has been estabstrengthening their relationships.

The 18 member Government - University -Industry-Research Roundtable Council, organized as an independent unit under the aegis of the council of the Naulonal Academy of Sciences (NAS), will address issues affecting and limiting the vitality of science in the United States, Thirteen of the 18 members are from universities and industry; 5 are senor federal officials. Dale R. Corson, president emeritus of Cornell University, is chairman of roundtable council.

The council is the overall guiding group for the ongoing research roundtable, accord-ing to Don I. Phillips, council executive director. The rouncil, which plans to meet three times a year, will spawn ongoing artivides (including workshops, working groups, and spe-cial studies) to keep communication open

among relevant groups. At its first meeting on May 17 and 18, the roundtable council agreed on a broad and comprehensive framework of issues. The theme overriding the framework is the need to establish, strengthen, and maintain a network among relevant groups to keep the lines of communication open. The research round-

table will focus initially on three issues: the relationship of srience and technology to economic competitiveness; the renewal of scientifir and technical institutions (including upgrading facilities and equipment, enhancing technology transfer, and the new partnerships between universities and state governments and between universities and industry): and the enhancement of rommunications between scientists, industry employees and government employees at the working

The roundtable was formed following the identification by several NAS panels of the need for an ongoing, neutral body to im-prove the communication and mutual understanding among those who fund research, those who carry it out, and those who use the results. NAS provided initial funding. Additional support has been made available by the Alfred P. Sloan Foundation and the Andrew W. Mellon Foundation. In addition to chairman Corson, other

members of the roundtable rouncil are William G. Anlyan, Chancellor for Health Affairs, Duke University Medical Center; Kenneth J. Arrow, Joan Kenney Professor of onomics, Stanford University; Marvin Cnhen, Professor of Physics, University of California, Berkeley; Edward G. Jefferson, Chair man of the Board, E.I. DuPont de Nemours & Co., Inc.; Sol Linowitz, Condert Brothers Law Firm, Washington, D.C.; Ceorge E. Pake, Vice President for Corporate Research Xerox Research Center; Alexander Rich, Sedgwick Professor of Biophysics, Massarline seus Institute of Technology: Howard A. Schneiderman, Senior Vice President for Research and Development, Monsanto Go.: Harold Shapiro, President, University of Michigan; Robert L. Sproull, President, University of Rochester; and Linda S. Wilson, Associate Vice Chancellor for Research, Uni

rersity of Illinois, Uchana Pacticipating feileral officials are Richard D. DeLauer, Undersecretary of Defense for Research and Engineering, U.S. Department of Defense; George A. Keyworth, H. Directo of the Office of Science and Technology Policy; Edward A. Knapp, Director, National Science Foundation; Alvin W. Trivelpierc, Director, Office of Energy Research, U.S. Department of Energy; and James B. vngaarden, Director, National Institutes of Health, Frank Press, NAS Presidem, is an exofficio member.

The next meeting of the research roundtable connect is scheduled for November 29 and

Viking Lander 1: New Exhibit

The National Aeronautirs and Spare Adinistration (NASA) transferred ownership of the Viking Lander 1, which landed on Mars in 1976, to the Smithsonian Institution's National Air and Spare Museum.

Requested by museum director Walter Boyne, the transfer includes the loan of the offirial Viking Lander plaque, which renames the lander the Thomas A. Mutrh Memorial Station in memory of the Viking Lander imaging team leader and NASA associate strator for space science. Mutch died in a rlimbing accident in the Himalayas in 1980. The plaque is scheduled to be placed on Mars by U.S. astronauts at some indefinite time. NASA retains reclaimant rights of the lander for scientifir purposes.

This is the first time that o museum will own an object located on another planet. Tourist visitation at the new exhibit is not yet expected to rival traffic at the parent museum.

U.K. Radio Science Reviews Available

biles, the International Union of Radio Science (URSI) publishes an International review of the most significant scientific developments over the previous 3 years in the nine subject areas covered by URSI's commissions. To produce this review, international editors distill reviews from each member country of national scientific developments. For those scientists who wish to know more details obout the significant scientific developments In radio science in the United Kingdom from 1981 to 1984, the Bridsh National Committee for Radio Science has made its reviews avail-

Unless otherwise noted, the following surveys are available from the Royal Society, 6 Carlton House Terrace, London SWIY 5AG, Auention: C.R. Argent. Commission A: Electromagnetic meteorolo-

gy, by J. M. Steele; available from J. M. Steele, National Physical Laboratory, Teddington, Middlesex, TWII OLW, Commission B: Fields and waves, by P. J.

B. Clarricoats. Commission E: Interference environment. by F. Homer.

Commission F: Remote sensing and wave propagation, by E. D. R. Shearman. Commission G: Ionospheric radio and

propagation by P. A. Smith; available from I. W. King, Rutherfurd Appleton Laboratory, Chilton, Didcot, Oxfordshire OX11 0QX.

Commission H: Waves and plasmas, by P. A. Smith; available from J. W. King, Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire OX11 0QX.

Commission J: Radio astronomy, by D. H. Martin; avadable from D. H. Martin, Department of Physics, Queen Mary College, Mile End Road, London El 4NS.

Geophysicists

Recently elected as officers of the Brazilian Hydrology and Water Resources Association are Antonio Carlos Tatit Holtz, president; Antonia Eduardo Leão Lanna, vice president: and Ciro Loureiro Rocha, Gilberio Valente Conali, and Orlando Vignoli Filho, directors. The new mailing and secretariat address is Associação Brasileira de Hidrologia e Recursos H(dricos-ABRH, A/C Gilherto Valente Canali, ELETROSUL/DIVH, Rua Deputado Antonio Edu Vieira, s/no-Pantanal, 88000 Floriauópolis, SC, Brasil.

In Memorian

Johnnes Theadoor Thijsse, 91, died April 9, 1984. An AGU Life Fellow and a nicinber of the Hydrology Sertion, he joined AGU in

Recent Ph.D.'s

Eas periodically lists information on recentaccepted dortoral dissertations in the disciplines of geophysics. Farulty members are in-vited to submit the following information, on institution letterhead, above the signature of the faculty advisor or department rhairman:

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(3) name of the degree-granting department and institution, (4) faculty advisor.

(5) month and year degree was awarded. If possible, include the current address and telephone number of the degree recipient

(this information will not be published). Dissertations with order numbers, and many of the others listed, are available from University Microfilms International, Disseria tion Copies, P.O. Box 1764, Ann Arbor, MI

lodide Enhanced Electron-Cupture Detection of Holocusbous with Application to Atmosphere Alethyl Chloride, Gwennlolyn Louise Ball, Univ. of Mich., 1983 (CAX84-02238)

The Kinetics of Sorption Reactions at the Geoth-Aqueous Interface (Desorption, Rate), Kerry Kiphari, Univ. of Notre Dame, 1983, (GAX84-03954).

Kinetic Studies of the Thermal Decomposition of Methylperoxynitrate and of Ozone-Olefin Reac-tions, Abraha Balua, Penn. State Univ., 1983 (CAX83-27470).

Martian Paleoclimate, Susan Elaine Postawko, Univ. of Mich., 1983 (GAX84-02360). Meau and Time-Dependent Motions in the Blake Escarpment Region, David Yuekchung Lai, Univ. of Rhode Island, 1983 (CAX84-01410).

Measurement and Avalysis of Diffuse Solar Irradiance, Clifford Brure Baker, Univ. of Mich., 1983 (GAX84-02235).

Miocene Stable Isotope Stratigraphy and Paleo ceauography (New Zealand, Spain, Pacific Ocean), Tom Stuart Louit, Univ. of Rhode Island, 1981 (GAX83-28479).

I, A Multi-Tracer Study of the Abyssal Water Column of the Deep Bering Sea, Including Sedi-ment Interactions. II, A Six Zone Regionalized Model for Bomb Radiotracers and Carbon Dioxide in the Upper Kilometer of the Pacific Ocean, John R. Toggweiler, Columbia Univ., 1983 (GAX83-27310).

Neotectonics of the North Frontal Foult System f the San Bernardino Mountain, Southern Caliornia: Cojon Pass to Lucerne Valley (Structure, Shp-Rate, Huzard), Kristian Erik Meisling, 1984 (GAX84-02492).

Photochemical Modeling of the Earth's Strato-phere, Lucien Froldevaux, Callf. Inst. of Tech., 1984 (GAX84-02489).

Prediction of Atmospheric Flow and Dispersion Over Sleping Terrain, Eueng-Nan Yeli, Univ. of Utah, 1983 (GAX84-02162). Reaction Mechonisms and Chromatographic Be-

havior of Polyprotic Acid Anions in Multicomponent Ion Exchange (Arsenic, Groundwater), Liou-Liang Horng, Univ. of Houston, 1985 (GAX83-28386). Reactions of Mutagenic Propylene Oxides with

des ond DNA, Zora Djuric, Univ. of Mich., 1983 (GAX84-02272). Rock Geochemical Exploration at Mount Movgan, Queensland, Australia, Mark Albert Fedi-kow, Univ. of New South Wales (Australia),

Sedimentary Response to Eocene Tectanic Rotation in Western Oregon (Washington, Pacific

News (cont. on p. 382)

Northwest, Petrology). Paul L. Heller, Univ. of Ariz., 1983 (GAX84-012fel). Sedimentalogy and Invertebrate Paleontology of Triassic and Jurassic Lacustrine Deposits, Culpeper Basia, Northern Virginia, Pamiela J. Wheeless

Gnre, 1983 (GAX84-01325). Stratigraphic, Geotheraical, and Petrologic Studies of the Ammouoovur Volcanies, North-Central Mascochusetts and Southwestern New Hampshire. Jishn Charles Schumacher, Univ. of Mass., 1988 (GAX84-01103).

Structure of the Breward Zone and Blue Rulge Near Lenour, North Carolina, With Observation on Oblique Cremulation Cleavage and a Preliminary Theory for Irretotional Structures in Shear Zones, Andy R. Bobyarchick, State Univ. of N.Y. at Albany, 1983 (GAX84-01429).

The Upper Proterozoic Redstone Copper Bell, Mackenzie Mountains, N.W.T., Charles W. Jefferson, Univ. of Western Ontario (Canada),

The Vertical Redistribution of a Pollutant Trater Due to Canadas Goosection, John Andrew Ritter, Univ. of Mich., 1983 (GAX84-02364). Watershed Acidification Afodel and the Soil Axid Neutralization Gapacity Concept, William G. Banty, McMuster Univ., Canada, 1985.

An X-Roy Stattering and Raman Spectroscopy Study of Iron (3+), Galliton (3+) and Germanitem (4+) Substituted Aluminosilicate Glasses. Grant S. Henderson, Univ. sd Western Ontarin (Canada), 1983.

Geophysical Events

Thes is a summonly of SEAN Bulletin, 9(4), April 30, 1081, a publication of the Smithsonian Institu-tion's Scientific Event Alex Network. The complete hulletin is available in the microfiche edition of Eo. as a microfic he supplement or as a paper reprint. For the inheoliche, order document E84–005 at \$2.50 (U.S.) from AtiU Fullillutent, 2001 Florida \$2.50 (U.S.) from AGO Fillindigen, 2009. For the paper reprint, orsier SEAN Bulletin lighting volume and issue numbers and issue date) through AGU Separates at the above address; the price is \$3.50 (or one cruy of each issue number for shose who do number a deposit account, \$2 for those who do; additive a deposit account, \$2 for those who do; additive a deposit a count, \$2 for those who do; additive a deposit a few himse number are \$1. Substitute. tional copies of on hissue isomber are \$1. Subscrip-tions to SEAN Bulletin are available from AGU Fulfillment at the above address; the price is \$18 for 12 mouthly issues mailed to a U.S. address, \$28 if mailed chewhere, and must be prepaid.

Volcanic Events

Rabaul (New Britain): Caldera cardiquakes up 60%, two seismie crises; expansion and uplift damble.

Manain (Bismarck Seat: Strong strombolian activity; rlebris avalanches. Langila (New Britain): Occasional vulcanian

explosinns fru 10 days. Campi Flegrei (Italy): Seismic energy release anil uplift slow after April 1 carthquake

Eina (Italy): Strombolian activity and small lava flows from SE crater. Hume Reef (Tringa Is.J: Large primice rafts;

new islamil shown. Submarine Volcano (Izu Is.): Acuustic waves recorded in French Polynesia.

Macdonald (S-central Pacific): Renewed submarine activity in 1983. Teahitia (French Polynesia): Seismic swarms

indicate twn submarine eruptions. Kilauea (Hawaii): 18th phase; four flows, longest flow of 1983-1984 eruption. Manna Loa (Hawaii): Major NE Rift Zone

eruption ends; tural eruption volume. Mt. St. Helens (Washington): Mud flow and vertical plume.

Veniaminof (Alaska): Vapor clouds; ash plsime to 2 km altitutle; iso glow. Pagan (Mariana Is.J: Dark emptinn columns. Atmospheric effects: Stratospheric aerosols

Rabaul Caldera, New Britain Island, Papua New Gumen (4.27°S, 152.20°E). All times are local (= UT + 8 hours).

The following is from Peter Lowenstein. "A further intensification of seismic activity in the Rabaul Caldern tonk place in April. The total mumber of caldera carthquakes was 18,749, BOS unite than in March (the March total was 8729; see last month's Bidletin). Seismicity was concentrated our the E side of the taldera, in Greet Harburt and at the entrance to Blanche Bay.

"Major seismic crises sucurred on April 21 and 22, when 1011 and 1717 events were recorded. The crisis on April 21 was centered at the mouth of Blaus he Bay, and the strongest earthurnake was a chagnitude (ML)-3.8 event. Oct): minot ground deformation was associated with this satisfic.

"On April 22 at 1100 an ML-4.8 earthquake heralited the must energetic crisis to date, which was rentered at the head of Greet Harbour. Structural damage in this and the Sulphur Greek area included stacking, and in one case collapsing, of masonry walls, cracks in corcrete fluors, a burst water malu, and burst fruuschuld water tanks. Tilts around Greet Harlamt ranged from 30 to 50 microradiaus, generally showing a pattern of radial Inflation centered in the Harbour. Measurements of Irraizvotol defirmadist indicated expansium of the Greet Harhour area by 20-

30 mlcrostrain The overall pattern of ground deforma-tion in April Indicated that the strongest tiltof up to 80 microradians, was in the Greet Harbour area. Rates of horizontal deformation indicated expansion was about

druhle that in any previous month (40-50 microstrain).

"Leveling surveys from Rahaul Township Matupit Island and around Greet Harbon slanwed that between mid-March and mid-April the Send of Matupit Island rose 76 min. Further uplifts of about 50 min on Ma-tispit Island and at the head of Greet Harbair accompanied the April 22 seismic crisis, making the total uplift in April about double

that in any jerevinus month. Infurmation Cuniact: Peter Lowenstein, Principal Correctment Volcanologist, Rahaul Vidcano Observatory, P.O. Box 386, Rabaul,

Panua New Guinea. Home Reef Volcano, Tonga Islands, S Parif-(18.99°S, 174.78°W). All times are local (=

UT + 13 hours).An early March eruption of Home Reef produced large quantities of pumire, ejected an eruption cloud to more than 12 km altitricle, and brilt a new island (see Eos, March 27, 1984). Tonga government geologist David Tappin reported that brown discolnred water preceded the eruption, which started March -2. The new island was visible by March 2. When Captain Jeff Heard of South Pacific Islands Airways flight 607 flew over the cruption site on March 5 at 1030, explosive activity had declined. Weak steaming occurred from a submarine crater surrounded by the

lit mid-March, a cargo vessel traveling from Tonga in fiji at 12 km per hour took 9 linurs to pass through a znae of pumite. nuples were collected from this vessel about 150 km W of Tringa. Primice rafts were rertedly sighted at Oucara Island, Lan Group (18.45°S, 178.50°W, roughly 500 km WNW of Home Reel) nn April 5. On May 1, ships between Tonga, Fiji, and Samoa reported that Hoating pumice was so thick that it was clog-

ging their seawater intake systems. Personnel from the Royal New Zealand Air Force (RNZAF) flew over the new island March 23. They gave its location as 19.02°S 174.73°W, about 10 km S of Late Island. Ditensions of the new island were estimated at 1500 in by 500 m, with cliffs about 30-50 m

high. Discolored water just NW of the island suggested submarine activity. Photographs taken from upwind showed the island to be yellowish brown in color, but atmospheric haze coused it to appear dark brown from downwind. David Tappin reported that activ-

ity was continuing in early April. The Réseau Sismique Polynésien (RSP) did not record any seisminity from the eruption. slands and deep water hetween Tahiti and Tonga prevented RSP stations from record-

ing any acoustic waves [T-phase]. Information Contacts: David Tappin, Government Geologist, Nukualofa, Tonga; Warrant Officer P. J. R. Shepherd, I SQN ALM LDR, RNZAF Whenuapai, Anckland, New Zealand; J. H. Latter, DSIR Geophysics Division, P.O. Box 1320, Wellington, New Zealand; J. Lum, Ministry of Energy and Mineral Resources, Private Mail Bag, Suva, Fiji; Rant Krishna, Director of Meteorology, Fiji Meteorological Service, Private Mail Bag, Nandi Airport, Fiji; J.M. Talandier, Directeur, Laboratoire de Géophysique, Gommissariat à l'Energie Atomique, 8.P. 640, Papeete, Taltii, Polynésie Française; Norman Banks, USGS Hawaiian Volcano Observatory, Hawaii Vulcanoes National Park, Hawaii 96718 USA.

Tenhitia Volcano, Society Islands, French Polyuesia, S Parific Ocean (17.57°S, 148.86°W). From August 1983 to March 1984, the Reseau Sismique Polynésien (RSP) recorded nuinterons sequences of luw-frequency volcanic tremor and two seismic swarms associated with shallow submarine eruptiuns at Teahitia. On December 20-21, 300 very small earthquakes were recorded. On March 3 to April 15, 1984, approximately 9000 earthquakes were recorded, accompanied by luw- and

high-frequency spasmodic and harmonic rremar. l'eahitia, a seamonni with a spoimir alignt 2 km below sea level, was the site of seismicity associated with submarine eruptions detected by the RSP in March-April 1982 and July 1983 (see SEAN Bulletins, 7(4),

and 3(8)). Information Contact: J.M. Talandier, Directeur, Laboratoire de Geophysique, Gommissariat á l'Energie Atomique, B.P. 640, Panecte, Tahiti, Polynésie Française.

Earthquakes

Information Cantart: National Earthquake Information Service, U.S. Geological Survey, Stop 967, Denver Federal Center, 80x 25046. Denrer, CO 80225 USA.

Meteoritic Events

Fireballs: Papua New Guinea; Hawaii, Mississippi River Valley, USA.

Correction

The names of the people who wrote the tribute for Mahdi S. Hantosh, which appeared May 22, 1984, were inadveriantly left off of the article. They are M. H. Ahmad, Ohio University, Athens, Ohio; G. W. Gross, New Mexicu Institute of Mining and Technology, Socorro, New Mexicu; M. A. Marino, University of California, Davis, California; S. S. Papadopulos, S. S. Papadopulos and Associates, in Rockville, Maryland; and Z. A. Saleem, Ebasco Services, Inc., Greensboro, North Carolina.

Earthquakes

Date	Time, UT	Magnitude	Latitude	Longitude	Depth of fneus	Region
April 23	0136	4.1 m _{bLs}	99.65°N	76.26°W	6 km	SE Pennsylvania
April 24	2115	5.7 m _b , 6.1 M,*	97.23°N	121.76°W	Itt km	Central California
April 29	0503	5.1 m _b , 5.6 M _e	42.92°N	12.14°E	shallow	Umbria, central luly

*6.2 M, at University of California, Berkeley.

formulating their ronclusions, through the

spectrum of various opinions has been rather

impressive. For instance, concerning predict-

ed estimates of the projected concentration

increase of COs (page 4), it is still not elear

what level the CO2 concentration will reach at

a given time at the given CO2 injection rate.

because the role of the negan hints in the

global carbon cycle and the contribution of

vestigation. Thus it is impossible to reliably

estimate the GO2 concentration doubling the

the biological control of geochemical cycles

bling will never happen at nll).

(and there are reasons to believe that a dou-

It is correct (page 22) that the possibility of

must be thoroughly analyzed. It is not correct

that climate changes are caused unly by exter-

nal impacts (page 5) such as solar variations,

volcanic aerosols, and "greenhouse" gases. In fact, an internal variability of the climate sys-

tem is also very important. In the very hegin-

ning the "scenario-type" character of the cur-rent estimates of CO2 climatic implications

should have been emphasized because [1] the

enough and (2) the adequacy of climate moti-

els, which are still unable to reproduce real

climate variability, is limited (this was done

only in the essay by R. E. Dickinson). In this

on the connection between die CO2 concen-

on veriations and cli

connection a note is very important (page 21)

analysis of ice cores that a CO2 concentration

acrease in the past could have been caused

by climate warning, but not vice versa. The

atement on pages 23-24 diat the effect of

douds on climate warming is manifested only as a positive feedback is thibious. In this con-

nection, it would be important to note that

the current impossibility of reliable consider-

ation of cloud-radiation interaction is one of

dicted climate. If an increase of CO2 leads to

even a small increase of doud amount, then a

the main causes of uncertainties of the pre-

cooling, not a warming, of climate is quite

possible. The book reviewed is on important

contribution to the literature on ellmatic im-

plications of CO2 increase. Naturally a lost of

authors has produced a rather controversial

picture. This, however, reflects the extreme

complexity of an interdisciplinary problem

still far from being solved. The book will be

of great interest to specialists in various as-

pects of the climate problem. The writing style will also make the book accessible to a

K. Ya. Kondruegen is with the Laboratory of Ra-mote Sensing, Institute for Law Research of the Academy of Science, 196199 Leavingrad, USSR.

wide circle of interested nonspecialists.

forecasts of CO2 increase are not reliable

the continental biosplicre require further in-

Carbon Dioxide Review: 1982

William C. Clark (Ed.), Oxford University press, New York, xi + 469 pp., 1982.

Reviewed by K. Ya. Koudraisev

A series of publications appeared in 1982 on climatic implitations of increases in CO2 concentration. Analyzing the status of numer ical modeling of GO₂ impact on climote, M. Schlesinger [Oregon State University] has compiled a summary of 66 models, which is, nevertheless, quite inadequale, since Sovier studies as well as some other investigations have not been considered. All those studies show that the recently growing interest in the problem of anthropogenic effects on climate is far from abating, which is quite natural in view of the enormous practical implications of the dimate change problem.

Since no climatic consequences of CO2 increase have been observed so far, the major way of studying this effect has been numerical simulation of varying complexity, aimed first at an approximate assessment of possible changes in mean global climate (characterized by air surface temperature), and then in zonal and regional climates considered in sophisticated three-dimensional models. Though the estimates of mean global climate warm ing, on the assumption of a tloubled CO2 concentration, vary widely, most of the experts believe that the value 3 ± 1.5 °C is most irkely. Rowever, this condusion is inconsistent with the results of studies carried out hy R. F., Newell and T. G. Dopplick and by S. B. Idso. Their results show that mean global warming should be about an order of magniverly uriticized and considered erronemus traftl that phylously averestimated values of

CO2 warning have not been so radically criti-In this connection three problems must be thorrughly dealt with: (1) the reliability of predicted estimates of CO2 increase, (2) the reliability of current numerical climate moulels, and (3) the possible hupact of the increased CO2 concentration on the biosphere. These and the possible effects of climate change on industry and agriculture are the puttlems considered in Carbon Dioxide Reviewed: 1982. The editor of the book justly notes in the preface that during the recent decade the CO2 dimatic implications have often been overestimated, and, therefore, an objective analysis of the status of the problem is needed in addition to "official" assessments. The book consists of part I, in which the oblem is considered on the whole, and part 2, in which seven rather substantial essays on key aspects of the CO2 problem are followed by comments of "opponents." The style of part 2 results in both more objective and more vivid presentation of the material, and the highly qualified participants of the dia-logue ensure its rich scientific contents

The main goal of the authors is to reveal the commonly agreed upon aspects ni the problem [based on reliable scientific argu-Engineering ments), and to analyze uncertainties, unsolved problems, and possible ways of their solution. The authors of the book have, on the whole, reached the goal, but sometimes they have not been sufficiently careful when

Reviewed by Raphurl G. Kazwann

It is an impossible task for one person to review the proceedings of a major conference that consists of 141 different papers finded ing 26 cme-page summaries of paster sersions). The papers are arranged into 55 actaient sessions including Cohesive and Non-Cohesive Sedingent Dynamies, Cold Regions Hydraulies, Computational Hydraulies, Groundwater Quality Modeling, Mixing Pro-cesses in Straulied Environments, Probabisis Approach to Hydraulies, and Surface Water Hydridiagy. The subject matter of many of the papers was familiar to the writer, specifically those concerned with groundwater and the hydrodogy, and leydraulles, of surface water. In addition, such topics as constal dynam ics, mixing processes in stratified environincuts, cidicsive sculiment dynamics (?), sediment resuspension und transport, and the hydraulic effects of ice cover are all to found in this vulume. The writer refrains from conment on these papers except to say that although some of the papers were comprehen-

Among the papers of general interest kase overview of dom safety by Bivens. We leaft that in 1089 that I among the transfer of the safety by Bivens. that in 1082 the U.S. Corps of Engineers it poried to Congress that some 91% of the P proximately 65,000 dams inspected were earth-fill. About 21,000 of the 65,000 dank deals with risk assessment and Wistrate possible trade offs between costs of sollies.

Frontiers of Hydraulic

Hung Tao Shen Jed.J. American Society of Civil Engineers, New York, xv + 617 pp.

sible, his experience is not basis enough for

The title of the volume is a trifle mislead ing; about 70% of the papers have little to do li engincering, if engineering is considered to be concerned with accomplishment in the real world. Most of these papers deal in absumptions that may easily be in error. No papers rely heavily on computer model and mathematical approximations of all kinds, with little or no field data that might lead one to try to apply the results in a similar sittle tion. Judging from the title of the book we might have expected to find more papers dealing with the application of current and proposed theory to the serious problems confronting the engineering profession. Perhaps a more accurate title for this volume would be Frontiers of Hydraulic Research.

the volume and a few concrete examples of what the volume contains. The book deserves a place in technical lioraries. It is an excellent point of departure for research. The papera show the kinds of hydraulic research that are being done, including what is being modeled, although these models are not yet in general use. Moreover, the list of references accompany ing each paper is a quick entrance into the

Raphael G. Kozmann is a consulting engineer,

Classified The sedimentation produced by the Mount

RATES PER LINE

improvements and annualized damages.

St. Helens eruption was closely studied, and

many field slata were obtained. One method

of forecasting deposition of the sediments is oumerical modeling, and a paper by Brown and Thomas describes the approach and

compares the field observations with the pre-

the model will receive much use and repeated

dictions. If the volcano continues to erupt,

field verification which will enable it, or a

confidence by the engineering profession.

scribes the attempt by the U.S. Ceological

modified version of it, to be used with some

Another paper, by Moss and Thomas, de-

Survey (USCS) to determine the effectiveness

of its stream-gauging program. The USGS operates approximately 15,000 stream gauges in the United States of which some 8,000 are

question addressed is, Are the records worth

equipped with continuous recorders. The

he money being spent, or could the same

fuods be spent in a more cost-effective man-

ner? The authors estimate that some 5-10%

of the continuous records could be replaced

by part-time operation of recorders, the de-

would generate synthetic flows that would ad-

equately serve the same purpose, or develop-

ment of a regression model of flow at the site

velopment of a flow routing model that

of interest whose results would compare

properly with flows at other sites. They de-

posals, especially one called The Travel-

ing Hydrographer, which is designed to allo-cate among stream gauges a predefined bud-get for the collection of field information in

the most cost effective manner. One topic not

addressed is how the increasing urbanization

of watersheds combined with improvements

in agricultural drainage will affect the stream-

gauging program since none of the proposed

pected to yield-the information needed in

The groundwater papers in this volume

were disappointing. Of the seven papers dealing with groundwater quality modeling, one

paper is just an abstract, five are mathematical models with no field data and no sugges-

tions as to how they might be used by a prac-

answer the question, How can the results be

used?. These may be "frontier" papers, but

than engineering. Perhaps they represent

they are on the frontiers of something other

frontiers of research in groundwater hydrau-

The papers on cavitation prevention and its

nitigation are, as a group, probably the most practical. Five of the eight papers on the top-

structures, and, as an example, one of these papers, by DeFazio and Wei, describes an an-

yucal procedure which combines analysis of

equation and compares the results with actual

bservations. A paper by Falvey presents cri-

teria, based on observations of damage in the

tion, for a flow-cavitation index, to help antic-

tpate cavitation on chittes and spillways. Oth-

er papers, equally practical, are to be found here and will be nf aid to engineers who de-

This reviewer's principal prublem with the

volume is the lack of an overview. No frame-

work is provided into which these papers may

be fitted. Even the smaller grunpings, which correspond to the sessions at which the pa-

pers were presented, leave a rather chaotic

er? It would seem that it is not enough to

state a theme, such as the "frontiers of hy-

draulic engineering," designate an editor to

ements, and then let matters take their course. Such an editor could not be expected

to evaluate the technical quality of the work

any more than a single reviewer could adequately evaluate all of the papers. Ideally,

such conferences should be planned so that

the convenor of each of the various sessions

will be able to prepare an overview of the ses-

gots the technical points discussed in

detail in the succeeding pages, For the actual sessions, more papers should be invited than

will be used in the proceedings volume. Pa-

pers that do not fit the theme of the session

overview could be modified to incorporate

them. Finally, in a brief review of so large a

volume, this reviewer is left with the feeling

that justice cannot be done. All the good pa-

pers cannot be listed, and the poor ones can-

not be critiqued. All that can be accomplished

is to give the reader a general impression of

ould either be rejected or, if need be, the

review the format and other technical re-

pression: How do these subjects fit togeth-

sign chates and tunnels.

field and practical constraints on construc-

the flow of an ideal fluid, with an empirical

ic deal with aeration devices in hydraulic

ticing engineer. One paper, by Freyberg. Mackay, and Cherry, does contain data from a field experiment, but nu attempt is made to

tutes for continuous records can be ex-

scribe a prototype study of 51 continuous stream gauges that is designed to test their

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POSITIONS AVAILABLE

Middle Atmospheric Research Position/NCAR.

The National Center for Atmospheric Research (NGAR), located in Boulder, Colorado is seeking a SCIENTIST I for the Clobal Observations, Modeling and Optical Techniques Section of our Atmospheric Chemistry and Aeronomy Division.

DUTIES: Carnes out individual and collaborative research on the stratosphere and mesosphere with the aid of satellite observations of tomperature and composition. Research is defined in collaboration with the project leader and may include (but is not limited to): middle atmospheric chemistry, dynamics, transports and radiation. Assists in defining scientific investigations and strategies; contributes as well to the planning and design of future satellite experiments. Derelops models to help understand middle atmospheric processes and interpret satellite data. Defines and performs calculations required in the validation and analysis of satellite data. Defines and performs calculations required in the validation and analysis of satellite and analysis of satellite and analysis of satellite of the second of these results. Leads or panicipates in writing papers and reports describing the results of these investigations. Aids in the supervision of and direction of co-workers involved in panicular tasks.

REQUIRES: Ph.D. in atmospheric science of

nasts.

REQUIRES: Ph.D. in atmospheric science or equivalent experience in theoretical or modeling studies, data analysis, experimental investigations or related areas. Demonstrated skill in programming on a large computer and willingness to work with large data sets. Demonstrated interestiskill in developing good working relationships. ALSO DESIRED BUT NOT REQUIRED: One year of post-ductoral middle amountaints research experience as demonstrate.

BUT NOT REQUIRED: One year of post-doctoral middle appropriete research experience as demonstrated by publications.

Salary range: \$25,814—\$38,722 per year.

NOTE: Scientist I appointments are for terms of up to three years; individuals may be appointed to the text level of brieflin in accordance with the UCAR Scientific Appointments Policy. Please send resume prompdy to Nancy Lippincott, NCAR, P.O. Box 3000, Boaddet, CO 80307 of wall (303) 107-8729 for further inductional parts.

8729 for further inductination NCAR is an equal opportunity/affirmative action

Physician/Computer Professionala. SSA1 carries on hardware/software engineering suppon service and R&D activities in various fields if applied physics and atmospheric sciences. We have contracts at NASA/NOAA/NAVY offices in nietropolitan Washington, D.C., area. For our on-going projects, we need systems programmers/analyst/scientists to carry our numerical modeling and analysis Studies in the areas of satellite remote sensing, climate research, atmospheic sciences/meteorology, astrono-metastorilyste/facilio-astronomy and planetary rethe areas of satellite remote sensing climate research, a mospheic science/meteorology, astronomy and planetary research. Applicants must have MS/PhD degrees and computational experience with large scale machines. Also, for a coming requirement in New York Chy SSAI is looking (or a Project Manager and a System Manager with progressively responsible supervisor; R&D experience with large-scale third fourth generation computer installation using 1BM 5033/3681, AMDAHL or CDC salarles, awards yearly bonuses and provides liberal fringe benefits. Please send your resume with salary history and references to: SCIENCE SYSTEMS AND APPLICATIONS, INC., 10210 Greenbelt Rd., Snite 640, Seabrook, MD 20700.

University of Csiifornis/Regional Seale Meteorology. The Department of Land, Air and Water Resources, University of Californis, Davis, announces a position in the area of regional scale meteorology. Tenore track (II mos, plos one mo. pald vacation) position will be divided 56% teaching and 62% research. The appointment will be at the Assistant Professor level.

QUALIFICATIONS: A Ph.D. in atmospheric science or a closely related discipline, with a specialization in regional scale meteorology. Applicants should have teaching and research interests in the quantitative aspects of meteorological processes occuring on the meso- and regional-scales 110 km to 1000 km) of atmospheric motion. The appointee will develop a research program that may involve any of several subspecialities and application areas but the analysis and modeling of wind fields in romplex certain would be expected to be a prominent part of the program. Teaching will include a graduate course in meso-tcale meteorology and both graduate and undergraduate courses in general areas of atmospheric science, and advising duties.

APPLICANTS: Applicants should submit curriculum vita, transcriptis, statement of research and teaching interests and background in each, copies of publications and manuscripts and the names and addresses of at least three references to L.O.

Myrup, Chair, Search Committee, Department of Land, Air and Water Resources, 265 Hoagland Hall, University of California, Davis, CA 95616, no later than August 15, 1884.

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Postdoctoral Fellowship in Geologic Remote Sensing. Start Fall 1984 for 12-month appointment—potentially renewable. We will be field testing a portable spectrometer (0.45–2.5 m) for use in quantity in the interpretation of multispectral remote images. The applicant should propose to make use of this capability in study problem(s) in geology, rock weathering, hydrothermal alteration, geobotany, petrology, etc. in the southwestern United States. Send viae to: Professor Arden L. Albee, Division of Geological & Planetary Sciences, California Insdicte of Technology, Pasadena, CA 91125 or Dr. Alexander Goetz, Jet Propulsion Laboratory, MS 183-501, California Institute of Technology, Pasadena, CA 91109.

Research Associate Position/University of Miaml. The Division of Meteorology and Physical Oceanography, Rosenstiel School of Marine and Almospheric Science, University of Miami, searches for a programmer/data analyst with several years of geophysical data analysis experience for processing and analysis of oceanographic data obtained by moored or shipboard instrumentation. Applicants should be experienced with FORTAN and preferably also with the VAY-VMS autemt lost detailed may occaexperienced with FORT KAIN and preteranty with the VAX-VMS system. Job doiles may occasionally include participation in crubes. The succ with the VAX-VMS system. Job doides may occasionally include participation in cruises. The successful applicant should have a Masters Degree in physical, mathematical or computer sciences. Application with curriculum vitae and names of three references should be sent to: Dr. Thomas N. Lee, Division of Meteorology and Physical Oceanography, Rosenstiel School of Marine and Atmosphetic Science, 4600 Rickenbacker Causeway, Miami, Florida 53149, by 15 June 1984.

The University of Miaml is a Private, Independent, International University and is an equal opportunity/affirmative action employer.

Chief of Telescope Operations/Haystack Observatory. Haystack Observatory has need for a Chief of Telescope Operations, who will be responsible for seheduling and coordinating astronomical observations using the Haystack 120-foot and 60-foot radio telescopes. The primary duties will be training and supervising telescope operators, scheduling antenna use for astronomy, maintenance, and other activities, and interfacing with investigators to assure the surcess of their observations. This person will also be the system manager of the HP 1000 computers used to control the telescopes and data acquisition hardware; some experience in FORTRAN is required for maintenance of the existing software. In addition, panticipation in the evaluation of the existility and merit of proposals to use the telescopes for astronomical observations will be required; thus, the successful candidate is expected to have some knowledge of astronomy. Since successful observing depends on proper use of equipment, some experience with the use of instrumentation for scientific data collection is highly desirable. A negotiable fraction of time will be available for research and participation in software or instrumentation development, depending on the qualifications and interests of the applicant. We seek an individual with supervisory and organizational skills who is interested in a long-term commitment to furthering the progress of astronomical research. Haystack Observatory is operated by the Massachusetts Institute of Technology for the Nonheast Radio Observatory Corporation, a rousoritum of Northeast institutions. It is located 40 miles northwest uf Boston in a rural environment, with easy access both to city activities and to the coasiline and mountains of New England.

Please write, enclosing resume to:

Please write, enclosing resume to:
J. T. Karaku
Assistant to the Director
Haystack Observatory
Westlord, MA 01886. MIT is an equal opportunity/affirmative action

Hydrogeologists/Consulting. The Bethesda, MD, office of Dames & Moore has caceer opportunities available in our expanding lazardous waste management group. We are looking for individuals at the entry level or with 4 to 10 years experience with the following qualifications: 11 Minimum of a B.S. in geology or hydrogeology, 27 Design and review of ground-water sampling and monitoring programs, 31 Groundwater modeling, 4) Analysis of romaniman transport, 3) Field experience, 6) Excellent communications skilb. Interested applicants should forward resumes to: Dames & Moores, 7101 Wisconsin Arenue, Suite 700, Bethesda, MD 20814, Aun; HG.

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Ocean Engineeriog Research/University of California, San Diego. The Institute of Marine Resources at the Scripps Institution of Oceanography, University of California, San Diego has three openings for assistant/associate research engineers or assistant/associate professors to participate in the development of ocean engineering programs. Candidates should have a Ph.D. or equivalent in engineering, physics or oceanography, a publication record and should have interest in taking part in research in one or more of the following fields: 1) deep ocean waves, remote and in situ measurement and snsiyses of directional spectra, and wave/structure interactions, 2) floating and fixed platforms, response to waves, structustal analysis, corrosion and Istigue, 3) ocean floor geotechnical studies, initiation of mass movements, scour and soft bottom anchors. The salary range is \$25,100-\$35,300, depending upon qualifications. Appointment distration two years with possibility of indefinite extension. Appointment as professor is subject to the availability of an appropriate department billet. Appointment at the associate kevel requires a record of successist funded research. Associate professor rank requires teaching experience. Send resume and names of references before 1 September, 1984 to; F. N. Spiess, Director, Institute of Marine Resources, or R. J. Seymour, Head Ocean Engineering Research Croup, Institute of Marine Resources, at Scripps Institution of Oceanography, La Jolla, CA 92093. An equal opponunity, affirmative action employer.

Climste Research finalitute/Research Assistant.

Applications are invited for a position as Research Assistant which is expected to be available in the Climate Research Insdittle, Oregon State University, beginning in September 1984. This position involves research in climate modeling and the analysis of related data, and requires a basic familiarity with atmospheric dynamics, modeling and slata analysis techniques. Salary within the range of \$18,000—\$20,000 will depend upon qualifications and expenence. Interested candidates possessing the M.S. degree in atmospheric sciences and at least two years ence. Interested candinates possessing are A.S. tegree in atmospheric sciences and at least two years
graduate-level experience are invited to submit an
application with a summary of their university and
research experience, and the names of (we professional references, to Dr. W. L. Gates. Directur, Ulmaic Research Institute, Oregon State University,
Corvallis, OR 97931 before 15 July 1984.
Oregon, State University for a William of the Programmity Oregan State University is an Equal Opportunity/ Affirmative Action Employer and complies with Sec-tion 504 of the Rehabilitation Act of 1978.

Research Observer/U.S. Dopartment of Commerce. Position in South Pole, Antaretica. Conducts scientific measurements at the NOAA Baseline Observatory. Will make measurements of amospheric CO2, orone, acrosols, other trace constituents, and meteorological parameters. This position is an electionics specialist (instroment). Responsibilities are calibration and maintenance of the Observatory instruments and data acquisition systems. We seek applicants with electronics technician background will at least 4 years of experience or electronics engineers with a least 2 years experience. The expenence should be specialized in electronic instrumentation calibration and trainienance.

This position is a 1S-24 month appointment. Duty station for the first 2 months will be in Boulder, Colorado for orientation and training, shen at South Pole, Antarctica. NOAA will supply guarters, food, clothing at no cost during the four of duty at the South Pole. The measurements sopply information for current atmospheric research unto climate and climate change. We offer an adventure as well as good salary (about \$30,000—\$40,000 per year, depending on qualifications and experience). For more information, cuntact Mr. Bernard Mendonca, U.S. Depan ment of Commerce/NOAA, 325 Broadway, Boulder, Colocado 80503; telephone FTS 320-6733 or commercial (303) 497-6733.

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Research Scientist, Earth Structure Studies

Energy, Mines and Resources Earth Physics Branch Ottawa, Ontario

We require a geophysicist/geologist to conduct field investigations and research studies into the nature and structure of major geological features throughout the Canadian landmass. Emphasis will be on the application of deep seismic reflection techniques, including vibrosesis, and regional three-dimensional seismic refraction methods. Other geological and geophysical methods will be incurporated as necessary. field investigations will be carried out in all parts of Canada, from the east and west coasts to the Arctic Ocean Basin. Research studies will dentand extensive use of state-of-the-art computer-hased processing and international methods. You require graduathm with a doctorate degree from a recognized university in geophysics, geulogy, physics ur a related field, or a lesser degree with evidence of research experience and productivity equivalent to that of a doctorate degree. Extensive experience in the processing and interpretation of multifield seismic reflection data is also regulred. Knowledge of either English or French is essential. We offer a salary ranging from \$26,834 tu \$49,913 commensurate with your qualifications and experience, Effective 23 June 1984, the revised salary range will be \$28,176 to \$52,409.

Forward your application form and/or resume, quoting reference number \$-84-31-5523-JG47(G14), to: Ioan Girling (613) 593-5331 Public Service Commission of Canada Ottawa, Oniarlo KIA 0M7

Closing date: 31 August 1984

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Assistant Research Geophyalelst. The Intilute of Geophysics and Planetary Physics or the Ocean Research Division of the Scrippa Intilution of Oceanography are considering the appointment of an assistant research group conducting electromagnetic soundings of the ocean floor. Applicants should have experience with land and oceanic EM measurements, a demonstrated capacity to design and construct equipment, and the ability to carry ou experiments at sea. A Ph.O. in geophysics or related sciences is required. Candidates should have some experience with the analysis and Interpretation of EM data. Salary range is \$25,100—\$26,100. Applicants must suismit a resume, coples of relevant publicotions, and the namer of three references by I July 1984 to:

Or. Alan Chave

July 1984 to:

University of California, San Olego
Institute of Geophysics and Planetary Physics
A-025
La Jolla, CA 92093.

The University of California is an affirmative acion/could concertually compleyer.

Micropalentologis/University of Puerto Rico, Mayaguez. Positini upen July 1, 1984. Assistant Professor level, tenure itak, \$17,820 per annum (9 months tearhing). Ph. B. required. Buties will involve leaching at the graduate level courses in the discipline being considered here, upervising student research and condurting personal research. Applicants should send attricolom viace, a brief statement of teaching and research plans and three letters of recommendation to Chairman, Appointments Committee, Department of Matine Sriences, University of Puecto Rico, Mayaguez, P.R. 60708, Telephone 804-832-1040, ext. 5443.

Research Position-Spaco Physics/Rice University.
The Space l'Irjeirs and Astronomy Department at
Rice University seeks applicants for one or more
full-time research positions within the department.
Surcessful applicants will play key role(s) in the development of theoretiral three-dimensional models
of the Earth's electromagnetic field. Applicant
should have knowledge of, and interest in, at least
one of the following areas: solar-wind magnetospilere interactions, magnetosphere-ionosphere roupling, ionosphere-atmosphere coupling, collisionless
plaima mirrophysis, atmospherir electricity. Experience ant/or interest in numerical modeling is an
important consideration.

rienter anitor interes in numerical modeling of an important consideration.

Title and talary level commensurate with expedience, tangling from one-year Research Associateship (tenewable in subsequent years depending on performance) to open-endral Retearch Sciential appointment in the Center for Space Physics. Please acid resume and names of three professional references to T. W. Ifill or R. A. Wolf, Space Physics and Automuny Oept., Rice University, Houston, TX 27251.

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University of Cambridge/Theoretical Seismologiat, It is hoped soon to appoint a postdoctorate to work independently in the general field of theoretical seismology. An interest in seismic modelling and interpretation, particularly of body-waves, would be smitable. Stimulating environment with other theoretical, refraction, teffection and carthquake seismologists. University salary. Send curriculum vitae to Professor C.H. Chapman, Dullard Laboratories, Department of Earth Sciences, University of Cambridge, Madingley Road, Cambridge CB3 CEZ, England, by 31 July 1984.

Research Associate/Research Technicina. The University of Maine at Orono (UMO) has an opening for a research associate/research technician who would work in a small geophysiral group. We seek an individual who can use and maintain modern digital electronic equiproent; for example, multichannel analysers, 10 interfaces for microcomputers, digital plotters and digitaling tablets. Familiarly with BASIC and FORTRAN will be needed, and some geophysical field work may be required as part of the distiles of the appointer. Current funding permits an appointment for at least 12 months. Subject to arrival of mulcipased funding, the appointment period rould be extended to two years, or longer. Call Edward R. Derker at 207-581-2158 or 207-581-2152 about the position. Otherwise, send inquiries, a sita and a list of at least three references to Edward R. Oecker, Department of Geological Sciences, 110 Boardman Hall, University of Maine at Orono, Crono, ME 04469.

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Research Associate/Brown University. Research Amociate in Planetary Geology at Brown University Providence, Rhode Island. Experience in geologic/ geomorphic analysis of planetary imager, study of rurface geologic processes, romputerized image processing, and/or quantitative geomorphology is desirable. Deadline for application is June 30, 1084 Submit resume, names and addresses of three reference to Dr. Janes Heal, Box 1846, Brown University, Providence, RI 02912. Brown University is an equal/opportunity affirma-

Postdoctoral Research Associate Posttlons/Geophysics and Igneoun Geochemistry. The University of Malne at Ornny (UMC) has postdoctoral openings for a solid cast h geophysicist and an igneous geochemist. We seek a geophysicist and an igneous geochemist. We seek a geophysicist who wishes to alwance fundamental undentanding of past and catent thermal histories of the Appalachian forgen itr New England and the where. The geochemist would be expected to investigate volcanic and phittonic soites in the Appalachians in Maine and in other terranes. Unrent funding penalts appointments for at least 12 months. Subject to arrival of anticipated funding, the appointments rould be extended to two years. Both appointment could use a carly as August 1, 1981. Excellent farilities for geothermal research, computer applications, petrologic research and geochemologic studies exist at UMO. Additionally, limited funds are wailable for travel and retearch, and the appointers will be encouraged to generote exterior support individually or through cooperation with existing faculty. Please seed inquiries, a via, a list of referees, and a description of research interests to Edward R. Occker or Daniel R. Lux, Department of Geological Sciences, 110 Boardman Holl, University of Maino at Orodo, Orono, Maine 0-1469, Telephone tills may be made to 207-581-2152, and forwarded to Occker or Lux.

The University of Maine is an equal opportunity/

Austrant Professor of Geology. A one term, re-newable Ipositive tenure track) position begint Sep-tember 1, 1984. Ph.O. is required; needs strong background, interest in sedimentology. Will teach graduate/undergraduate courses in specialty and have strong interest in research. Salary commentu-rate with qualifications and experience. Review of nave strong interest in research. Salary commenda-rate with qualifications and experience. Review of credentials begins June 30, 1984. Send vita, state-ment of tearhing and research interests and names of four references to: Search Committee, Oepan-ment of Geology, Eastern Washington University, Cheney, YA 99004. An equal opportunity employer.

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Research Associate/University of Maryland. The Space Physics Group of the Oepartment of Physics and Autonomy has an opening for a Research Assoriate beginning as early as July 1, 1984 for an initial one-year period with high likelihood of extention. The position involver research on energetic particles of solar and interplanetary origin. Applicants should possess a Ph.D. in a relevant area of physics or astrophysics; relevant research experience is highly desirable. Inquiries and applications should be addressed to Professor Glenn M. Mason, Oepartment of Physics and Astromomy, University of Maryland, College Park, MO 20742. Applicants should send a vits inrividing complete bibliography and a description of research experience, and rhould arrange for the rending of at least three letters of reference.

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Postdoctoral Fellow lo Igneous Petrology. Available August 15, 1984, duration of 1-2 years. Areas of research include mineralogy/petrology/geochemistry of kimberiltes and lunar rocks. A working knowledge of the electron micropobe is required. Please send resume, thost summary of research goals and the names of three persons who may be rontacted for recommendation to:

LA. Taylor

University of Tennessee

Department of Geological Sciences

Knowille, TN 37996

Telephone: 615-974-6013

Postdoctoral Research Positions in Planetary Atmospheres/Lunar sod Planetary Laboratory, University of Arlzons. Applications are invited for postdoctoral research positions at the Lunar and Planetary Laboratory, University of Arlzona, in Turson, Arlzons. The two positions will involve research in planetary physics and analysis of UV dats from the Voyager musion. Research opportunities for these positions include the bound and extended atmospheres and knoupheres of the giant planets and their satellites, the lo plasms torus, earth's atmosphere, the interstellar medium, and the atmosphere and lonosphere of Venur. Applicants should have a strong background in theory and dats enalysis. Physichis and astronomers are encouraged to apply, Curriculum Vita, bibliography and three letters of reference should be sent by July 15, 1984, to Dr. A. L. Broadfoot, Lunar and Planetary Laboratory, University of Arizona, 3625 E. Ajo Way, Tuscon, Arizona B5713.

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Meetings

Announcements

Water Quality Modeling

September 6-7, 1984 Conference on Stormwater and Water Quality Management Modeling, Hamilton, Ontario, Canada, IWilliam James, Civil Engineering Department. McMaster University, Hamilton, Ontario, Canada, L8S 4L7.)

The deadline for submitting abstracts is

]uly I, 1984. Conference talks will concern modeling pollution from urban and industrial sources. Papers are particularly solicited on emerging microcomputer hardware and software techniques in stormwater, flood, and pollution

Tar Sand Symposium

June 26-29, 1984 WRI-DOE Tar Sand Symposium, Vail, Colo. Sponsors: Western Research Institute, U.S. Department of Encrgy. (L. C. Marchant, Western Research Institute, P.O. Box 3395, University Station, Laramie, WY 82071; tel.; 307-721-2203.)

Technical sessions will run from June 27-29, with informal technical discussions planned for June 28. Among the topics addressed by formal speakers will be resources, in situ extraction processes, bitumen properties and ungrading, mining and plant extrac-tion processes, and environmental and economic concerns.

Environmental **Data Users**

August 19-22, 1984 Pathways and Future Directions for Environmental Data and Information Users, Denver, Colo. Spunsor: NOAA. (SES, Incorporated, P.O. Box 2697. Springfield, VA 22152.)

Early registration deadline is July 1, 1984. The objective of the conference is to increase user awareness of the range of environmental data available to the public. The program will consist of panel presentations followed by question and answer periods. The use of curironnental data in many disciplines will be addressed, including legal and insurance industries, travel and recreation industries, communications and aerospace industrics, urban and regional planning, renewable re-sources management, health and natural hazard monitoring, architecture and engineering, and marine exploration and coastal zone elopment. There will also be exhibits and displays from each of the four data renters of the National Environmental Satellite, Data, and Information Service.

Magnetism and Magnetic Materials

November 27-30; 1984 Thirtieth Annual Conference on Magnetism and Magnetic Ma-terials, San Diego, Calif. Sponsors: American Institute of Physics, Magnetics Society of IEEE, (John Scott, American Institute of Physics, 335 East 45th St., New York, NY

The deadline for submitting abstracts is July 6, 1984.

The purpose of the conference is to bring together scientists and engineers interested in recent developments in all branches of fundamental and applied magnetism. Emphasis is placed on experimental and theoretical research in magnetism, the properties and synthesis of new magnetic materials, and advances in magnetic technology. The program will consist of both invited and contributed

Meeting Report

Yosemite Conference

A conference on Planetary Plasma Enviconments: A Comparative View was held in Yo-semite, Calif., January 30 to February 3, 1984. The purpose of the conference was to discuss the comparative aspects of planetary and cometary plasma systems. Major support for the conference was provided by the Na-tional Aeronautics and Space Administration, Offire of Space Science and Applications. Additional sponsorship was provided by Ball Aerospace Ssytems Division, TRW Space and Technology Group, the American Geophysical Linkon and Stanford Linkonship. cal Union, and Stanford University.

Over the last 10 years, we have obtained important new information on the planetary plasma environments of Venus, Jupiter, and Salurn. In addition, there are several planned cometary flyby and rendevous missions which will be taking a first in shu look at these interesting objects in the next 5 years. This,

compled with the increased exploration and understanding of the earth's system (particularly the study of magnetosphere-ionosphere compling, which has been the subject of sever al past Yosemite meetings), made the topic of comparative planetary plasma environments an excellent chuice for the fifth biennial Yosemile inpical conference.

The pringram was urganized into five main sessions. The opening session provided an overview of the major nurphological features of planetary and contetary systems. The following two sessions discussed the planna and energy sources that operate in these systems. These early sessions provided the framework for the limit two sessions, which dealt with the interaction of the various plasma components ul the systems and with the commonality of the physical processes that take place within the solar system environments.

Chris Russell of the University of California, Los Angeles hegan the lirst session with a whirlwind tour discussing the solar wind interactions with various inner solar system budies. The nater planets were then addressed by Ralph McNutt of the Mastachusens Institute of Technulogy, and Tom Cravens of the University of Michigan discussed the interaction of corners with the solar wind.

The first session identified several interesting questions that were explored in subsequent sessions of the conference. [1] What is the nature of the solar wind interaction with Mars? (2) How important is the role of ionospheric plasma as a source of magnetospheric plasma at the outer planets? (3) What is the difference between the solar wind/comet and the solar wind/Venus interactions? These questions untoutly stimulated much discussinn throughout the conference, but alto sug gested future planetary missions and instramentation that curld help address these ques-

The second session focused on sources of plasma within planetary and cometary typtems. Dnug Torr discussed the role of both electron precipitation and solar EUV production of innospheric plasma with emphasion the need for proper calibration of the existing solar EUV data sets. He indicated that is regions of the EUV spectrum there may be as much as a factor of 3 error in the widely used Hinteregger EUV Huxes and that proper calbratiun can help to explain the lung standing discrepancy between the modeled and measured photoelectron spectrum.

Tamas Combosi contrasted and compare the structure of the Venusian, Martian, and terrestrial kanaspheres. While O' is the major ion in the upper immsplicre for all these planets, the minnr ion composition is weighted toward nitrogen-derived ions for earth and carbon divaide-derived lons for Venus and Mars. It was also noted that the maine nance of the nighttime Venusian ionosphere is the mainly to ion llows from the dayade driven by plasma pressure gradients, rather than particle precipitation as lirst suspected from early Soviet Venera Data.

The innospheric structure in the ouer planets was reviewed by Sushil Atreya. He in dicated that in the high latitude ionospheres of Jupiter, Saturn, and Urams the apport precipitation energy is large enough to provide the dominant source of indization but that at low and mid-latitudes, splar EUV sources were thought to dominate.

Asoka Mendis identified four possible sources of ions for comelary systems (1) pho-luludization, (2) charge exchange with solar wind ions, [3] electron impact lonization, and (4) critical velocity ionization. He reviewed both chemical and dynamical modeling of comets, unting some uf the controver ideas that have developed from these mod These ideas fueled the discussion that for luwed the talk. The discussion centered of the role of friction, between the dust and the escaping gas in a connetary system, at a mean of providing a choke for a transonic gas es-

pansion in the cometary atmosphere.

The solar wind as a source of ionization in inagnetospheric systems was discussed b Tim Eastman. Tim estimated that about 7: 10²⁶ ions s⁻¹ enter the frontside magneto sphere from the sular wind. He suggest that in quiet times the solar wind source doinhated the plasma sheet composition yet in storm times the earth's ionosphere beame the dominant source of plasmasheet plas He suggested that effusive processes ed with wave particle interactions is a major process for solar wind plasma entry to the earth's magnetosphere and that magnetic merging is less significant. Tom Hill dismerging is less significant. Tom raw agreed with this point of view during the discretistive. cussion period, suggesting that the importance of the two processes is still an

open question.
Critical velocity ionization was discussed by
Patrick Newell of the University of California.
San Diagrams of the University of California. San Diego, Although Than, Io, and comple liave been suggested as locations where this effect might be an important source of long don, very little experimental evidence for crideal velocity ionization in space plaints ists of this time. Peter Banks, nevertheles, ists of this time. Peter Banks, nevertheles, suggested that this medianism might be responsible for the high lon densities (5 x 10 cm.) seen around the space shutle during

The energy sources session next focused attention on the energization of plasmas in planetary systems. Bill Knudson began the session by discussing plasma energization at the inner planets with particular emphasis on Veitus using Pioneer Venus measurements. He indicated that as one crosses from the solar wind through the mantle interaction re-gion to the Venusian ionosphere, the election temperature goes from 10 to 100 eV due to ion exchange widt the solar wind. Waves are also produced by the solar wind interaction that, through Landau dainping, serve as a heat source for the topside ionosphere. Knudson estimated that about 5% of the so-

dayside orbital segments on STS-3.

into the ionosphe This behavior of a fairly direct energization of the planetary plasma at Venus was contrasted with more complex solar wind/magne osphere energization processes in a review by Michael Schulz. The observed monotonic decrease of energetic phase space density with decreasing L indicates that the plasma energization in the earth's magnetorphere is intrinsic to the inward transport driven by solar wind/magnetospheric convection,

ar wind energy incident on Venus comes

Alex Dessler gave an interesting talk, suggesting that planetary rotation, by exerting a magnetic torque, may be a general source of energy for magnetosphere systems. He indicated that diere are two ways to supply the torque: (1) to have an internal plasma source such as Io in the Jovian system or (2) to have an external plasma source such as the solar wind. Alex and coworkers have done some recent calculations, indicating that this may be an important source of energy for the magnetospheres of Jupiter, Saturn, Uranus, and possibly Neptune.

In the absence of collisions within planetary plainia systems, waves provide the required dissipation and thus serve as important means of redistributing energy within the system. Maha Ashour-Abdalla suggested that there are two types of wave healing: (1) quail-linear heating by many low amplitude wave modes, or (2) heating by a few strong wave modes where particle orbits that were originally bounded become unbounded and stochanic. The remainder of her presentation dealt with a specific example of the latter

While the first three sessions dealt with the separate elements of planetary and coinciary plasma systems, the funrth session timeractive plaima processes) addressed the interplay be-Iween the separate components. The session began with a presentation of some examples of terrestrial inagnetosphere-ionosphere cou-

pling proresses. Hunter Waite reviewed recent results from the Dynamics Explorer satellite program. These included recent studies on ion-neutral coupling processes and also DE I observa-tions of low-energy ion outflows observed at high latitudes in the terrestrial magnetosphere. In particular, significant fluxes of 0* are commonly observed flowing out of the lonosphere at high altitudes over the polar

A review of terrestrial ionosphere-magnetospitere modeling was given by Dick Wolf. Carl McIlwain questioned the substorut scenario and suggested that the magnetic field configuration might simply set up the electric field that then led to auronal precipitation. Carl Mcllwain and Peter Banks both asked if it was possible that mass loading of the high latitude magnetosphere was an important consideration for the convection electric field, a question certainly inspired firm earlier presentations on mass loading of the solar wind at Venus and in comet systems.

Janet Luhniann presented results on the Venus-solar wind interaction. She indicated that there is a conversion of solar wind dynamic pressure to magnetic pressure that is matched by the ionospheric pressure at the ionopause. The solar wind dynamic pressure controls the altitude of the ionopause. When the allitude approaches its minimum ob-served value of 200 km, large-scale magnetic fields develop within the ionosphere. These helds, according to Luhmann, can be explained as a result of a combination of vertical convection of magnetic flux from the ion-opause and diffusion. Rob Wolfe, however, asserted that the Cloutier model of the interaction does not agree with this interpretation. In the Cloutier model, a large-scale current system is driven in the ionosphere by absorption of solar wind plasma. A long discussion on the virtues of both model ensued, and it was clear that more careful study will be required to determine which physical scenario produces the correct magnetic field within the Venus ionosphere.

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The emphasis then switched to the outer planets and the interesting new results that show die importance of moons and rings as sources and sinks of magnetospheric plasma, Chris Goeriz categorized the effects of moons by whether they had an atmosphere and

whether they were magnetized or not. The interaction of comets with the solar wind was revuited by W. H. Ip. Again, the contrast of the cometary case with the Venus interaction focused on the greater degree of mass loading ahead of the shock and possible strong wave particle interactions dial rould lead to the formation of a weak cometary bow shock. Ip also suggested that the wavy or kinky configurations observed in cometary ion tails are indicative of Kelyin-Helmholtz or

Rayleigh-Taylor instabilities triggered by snlar wind discurbances. In addition, Rick Elplic presented some evidence of filamentary structures in the Venus nightside ionotails that are quite suggestive of comet ion tails and may serve as further evidence of similar physical processes in the Venus and come-

tary/solar wind interactions. The final session attempted to identify and describe some of the common plasma processes that occur in solar system plasmas. Ron Lepping began the session with a talk on how slock and magnetopause furmotion. All plan-ets observed to date have a bow shock and all but Venus have a magnetopause. The chararteristics of the bow shocks of planets depend strongly on the solar wind conditions, whereas the shape of a magnetopause will depend crucially on the detailed three-dimensional pressure profile it presents to the solar wind.

Acceleration proresses in plasma systems appear to be an important common process monstrated by the observation of auroras at Earth, Jupiter, Saturn, and Uranus.

Tom Hill opened his talk on the subject by indicating that acceleration of particles in a magnetosphere implied the violation of the rules of MHD. He classified these processes according to the invariant violated and showed that his was self-consistent with classifying acceleration processes according to their timescales or their physical mechanism. He concluded by pointing out three new challenging questions for future cointemplation: [1] What produces energetic particle bursts? [2] Why does the lo plasma toros heat as it moves radially outward from Jupiter? (3) Why is O+ arcelerated in the terrestrial polar

Transport processes within plasma systems were reviewed by Ceorge Siscoe. Charged particles move through magnetospheres in three ways: (1) convection, (2) diffusion, and (3) field-aligned winds. Charge exchange, however, also causes mass transport by converting magnetically bound ions into fast unbound neutrals. Steady and nonsteady convection is driven in the earth's magnetosphere by merging between the planetary magnetic field and the solar wind magnetic field. This is to be contrasted with the magnerosphere of Jupiter, where convection may be driven by eentrifugal force acting on an inhomogeneous distribution of corotating plasma. Siscoe also noted that when induced electric fields are present, as must be the case during magnetic field collapse or inflation, magnetospheric motions are not necessarily reflected in ionospheric motions. Nonsteady magnetic mergirig can also generate plasma bubbles (plasmoids) which are a source of field-aligned winds. Diffusion is needed to account for particles with energies higher than the convection potential and is important in the earth's radiation belts and possibly in Jupiter's middle magnetosphere. Transport processes can also be driven by atmospheric circulation. Indeed, in a magnetosphere, stresses on both ends of a magnetic field line must be balanced and communicated by means of field-aligned currents.

Meetings (cont. un p. 386)

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Meetings (cont. from p. 385)

The coupling between the upper atmosphere and magnetosphere was further ad-dressed by Ray Roble. He used as an illustrative example the terrestrial case where both solar EUV healing and ion-neutrul coupling produce strong forcing on the high laitude upper almosphere. Although separate nu-merical models of global electrodynamics, ionospheric dynamics, and thermospheric dynamics for the earth now exist, the next major step in understanding this interaction is to couple these models together. This work is now in progress. It was also pointed out by several people at the conference that the large auroral energy inputs at Jupiter, Sat-urn, and Uranus would also result in complex coupling between the magnetosphere and upper atmosphere, as is the case at earth.

The energetics of planetary plasmas was addressed by Larry Brace. He used as contrasting examples the ionospheres of Earth and Venus. Both planetary ionospheres are heated by photoelectrons and by wave-particle interactions generated at important plasma boundaries (e.g., the plasmaplause at Earth and die ionopause at Venus). Larry also mentioned the observation of electron temperatures of greater than 10,000 K in the terrestrial dayside autoral zone and cusp, which may help to explain the presence of low-energy O* ion outflows observed over the polar can on the DE spacecraft. The elevated electron temperature may increase the ambipolar electric field enough to enable O+ to overcome the gravintional barrier and es-

Sources and losses of plasma were cidlectively dealt with hy Peter Banks on the ionosphere as a source of magnetospheric plasma and hy Amly Cheng on rings and moons as plasma sources. Feter covered the evolution of our ideas on the source of plasma in the

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earth's magnetosphere. While in the 1950's all plasma was thought to come from the solar wind, recent DE measurements now sug gest a plethora of low-energy H+, He+, and ions coming out of the earth's high latilude ionosphere. He suggested that this could cause us to reexamine some of our theoretical understanding of polar wind processes.

In outer planet magnetospheres, the pre-sent emphasis is understandably on the relatively new phenomenon of moons as a source of magnetospheric plasma. Cheng Indicated that source mechanisms for particle escape from the moons included sputtering, sublimation, thermal escape, and ion pickup. Neutrals can escape before they are ionized. Satellites and rings can also lead to a loss of plasma. These loss processes include satellite sweeping, absorption, and wave-particle inter-

Richard Thorne gave a theoretical review of wave processes in planetary magneto-spheres. He began by stating that waves dom-inate magnetospheric dynamics by (1) providing rapid loss of energetic particles, (2) relaxing unstable distributions, and (3) providing energy equipartition. He went on to clarify that in magnetospheres, transport dominates in the outer magnetosphere and loss rates from wave processes dominate in the inner magnetosphere. Lori Lanzerotti still felt this to be an oversimplification. He stated in a comical, yet serious, fashion that waves dominate everywhere, except where there are exceptinns, such as (1) particle collisions in cold, dense torl; (2) rings; (3) satellites; and (4)

Thus, the conference ended as It began, in debate and good scientific exchange. The conference, by being broad in scope, not only provhled each scientist an opportunity to look at the overall picture and actually become involved in comparative magnetospheric physics, but also assured that no one could be an

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expert on everything. All attendees left knowng more than they did when they arrived. More specifically, the conference indicated the need to carry out some cometary missions

to take advantage of the vast amount of in-formation on the Venus-solar wind interaction collected by Pioneer Venus. The conference indicated the need to fly an ionospheremagnetosphere mission to Mars to understand the nature of the solar wind interaction with that planet. The conference also suggested that further measurements of the dynamical motions and the ion outflows (over the thermal to MeV energy range) from the high latitude ionospheres and thermo-spheres of the outer planets would contribute gready to our study of magnetosphere-ionosphere coupling processes. On a more practical note, suggestions were made to (1) do a careful comparision between Cloutier's model and other models of the Venus solar wind interaction, (2) complete reduction of the lower ionosphere data of the Jupiter and Saturn ionospheres because these measurements are important in determining the ionospheric conductivities and thus the degree of coupling between the ionospheres and magnetospheres in these systems, and (3) move forward with coupled chemical and dynamical models of cometary and planetary system.

This meeting report was contributed by J. H. Waite, Morshall Space Flight Center, Huntsville, Ala., ond C. R. Claver, STAR Laboratory, Standford University, Standford, Calif.

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Vertical Crustal Motion: Measurement and Modeling October 22–26, 1984, Harpers Ferry, W. Va. (Abstracts due August 1, 1984)

1984

June 4-6 International Conference on Inverse Problems of Acoustle and Etastle Waves, Ithaca, N. Y. Sponsor: Cornell University. IYih-Haing Pao, Department of Theoretical and Applied Mechanica, Cornell University, Ithaca, NY 14835; tel.: 607-256-2345.) June 4-7 Symposium on Climate and Paleoclimate of Lakes, Rivers, and Glacters, Igis, Austria. Sponsor: International Commission on Climate, IAMAP, tM. Kulm, Institut für Mercorologie und Genphysik, Schoepfatrasse 41, A-6020 Innsbruck, Austria.) (Oct. 25, 1983.) June 4-8 IWRA Seminar on River Basin. Strategy, Linköping, Sweden. (U. Lohm, Water Theme, Linköping, Guiv., 5-58183, Linköping, Sweden.) (Oct. 18, 1983.) June 4-8 Sevenul International Conference on Atmospheric Electricity, Albany, N. Y. Sponsors: IAMAP International Commission on Almospheric Electricity, AMS, and AGU. (R. E. Orville, Almospheric Electricity Conference, E.S. 214, 1400 Washington Ave., SUNV, Albany, NY 12222; rel.: \$18-457-3987.) (July 26, 1983.) June 4-8 Third International Conference on Urban Storm Dralnege, Göteborg, Sweden. 5ponsors: IAMR and International Association on Water Pollution Research. [P. Malmqvin, co Dept. of Hydraulics, Chalmers Univ. of Technology, S-412 96 Coteborg, 5weden.] June S-6 Ogallala Sympasium II, Lobbock, Tex. Sponsors: Texas Tech University Water Resources Center, International Center for Arid and Semi-Arid Land Sturlies, High Plains Underground Water Conservation District, Oklahoma State Univ. Div. of Agriculture, USGS, IVRC, Texas Tech, Umiv., Lathack, TX 79-189; tel.: 806-742-8597.) (May 1, 1984.) June 6-9 Second American Cantletence on Ice

742-8597.) (May 1, 1984.)
June G-9 Second American Conference on Ice Nucteating Bacterie, Flagstall, Ariz. (Ralph M. Dilby Research Center, Rox 6013, North-ern Arizona Univ., Flagstall, AZ 80011.) (Nov.

at. Duby Research Center, New 2013, Northern Arizona Univ., Flagstall, AZ 86011.) (Nov.
15, 1985.)
June 10-12 Canadian Hydrology Symposium
V884, Quebec, Canada. Sponsur: National Research Council of Lanada Associate Commiltee on Hydrology. (H. R. Whiteley, School of
Engineering, Univ. of Guelph, Guelph, Outario N1G 2Wt.) (May 1, 1984.)
June 10-15 65th Annual Meeting of the
Antertean Association for the Advancement
of Sefence (Pactic Division), Sau Francisco,
Calif. (John H. Vann, Dept. of Geography,
California State Univ., Hayward, CA 94542;
tel: 415-881-3193, 1 Jan. 31, 1984.)
June 11-12 Flith European Conference on
Environmental Pollution, Austerdam, The
Netherlands. IV. M. Dhanager, Dax 1779,
Cornwall, Ontario Kill 5V7, Canada.]
June 11-13 Symposium on Critical Assessment
of Forensting in Western Woter Resource
Management, Scaule, Wash. Sponsora: AWRA
and AGU, IG. R. Minten, President, Resource
Flanning Assoc., 113 Lynn St., Scaule, WA
98109; icl.: 200-282-1881.) (May 15, 1981.)
June 11-13 American Astronomical Society
Meeteles Bakintenn Att Unifical College.

98109; fel.: 208-282-1681.) (May 15, 1981.)
June 11-13 American Astronomical Society
Meeting, Baldmare, Mid. (Richard C. Fleury,
Physics Dept., Julius Hapkins Culv., Bultimore, MD 21218.)
June 11-15 International Conference on Agriculture and Environment, Venice, Italy. Organizers: Aldo Ginrgint, Puratue Univ.; Franco Zingales, Univ. of Paclua. (Aldo Ginrgint,
School of Civil Engineering, Purdue Univ.,
West Lafayette, 1N 47907; jel.: 317-19-1-2175.)
June 14-15 Conference on Delineation of
Landalide, Flash Flood, and Debris Flow
Hazards in Utaly, Logan, Utaly. Sponsors: Landelide, Flash Flood, and Debris Flow Hazards in Utah, Logan, Utah. Sponsors: Utah Water Research Lalmratory, Utah State Univ., Utah Geological and Mineral Survey, National Research Conneil Committee on Natural Disasters, and Utah Science and Technology Cooncil. (David Dowles, Utah Water Research Laboratory, Utah State Univ., UMC 82, Logan, UT B4322.) (May 8, 1984.1 June 17-25 Second International Trainsml Conference, Las Vegas, Nev. (Tsunami Society, 80x 8523, Honololu, Fl1 96815.) June 18-22 Fifth International Conference on Finite Eloments in Water Resources, 8urling-ton. Vt. Sponsors: Univ. of Vermont, AGU.

June 18-22 Fifth International Conterence of Finite Eloments in Water Resources, Surfington, VI. Sponsons: Univ. of Vermont, AGU.
(J. P. Lalble, Dept. of Civil Engineering and Mechanical Engineering, Univ. of Vermont, Burlington, VT 03-105; jel.: 802-856-8800.)
(May 29, 1984.)
June 19-21 Third International Conference on Martina Simulation, Rotterdam, The Netherlands. Sponsor: Maritimo Research Institute Neitherlands. (Secretariar MARSIM 84, do Mantime Research Institute Neitherlands, P.O. 80x 1565, 3000 DN Rotterdam, The Netherlands.)

June 20-22 Indiana Water Resources Association Fifth Annual Symposium, Bloomington, Ind. Sponsors: Indiana Water Resources Association, AGU, ASCE (Indiana Section). (Icifirey Martin, U.S. Ceological Survey, 6023 Nicuion Rd., Sulte 201, Indiana polis, IN 46254; tel.: 317-927-8640.) (May 29, 1984.)

June 22-26 Practical Applications of Groundwater Geochemistry, Banff, Alberta, Canada: Sponsors: the Alberta Research Council and the National Water Well Association. (David Nicisen, NWWA, 500 W. Wilson Bridge Road, Worthington, OH 43085.) (April 24, 1984.)

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June 24 International Conference on Geomembranae, Denver, Colo. (A. I. Johnson, Woodward-Clyde Consultants, 7600 E. Orchard Rd., Englewood, CO 80111; ed.: 303-694-2770.)
June 24 International Symposium on Impermeble Darriers for Soil and Rock, Denver, Colo. JA. I. Johnson, Woodward-Clyde Consultants, 7600 E. Orchard Rd., Englewood, CO 80111; ed.: 303-694-2770.)
June 24-30 Hith International Conference on Mathematical Geophysics, Loen, Norway, (L. Tminid, NTNF/NOR5AR, P.O. Dox 51, N-2007 Kjeller, Norway; telex: 181-17 kcin.)

June 25-27 Technology Transfer Society
Ninth Annual Meeting and International
Symposium, Doston, Mass. [Margaret McNamara or Jack Griffin, Naval Uniterwater Systems Center, New Lomlon, CT 06320; tel.:
203-4-0-4590 or -1116.]

Fig. 5 porisors: NOAA, IEEE, SAE-AE4 Committee, and severat military and civilian air transportation agencies in the U.S. and UK. (I. J. Faher, Conference Chairman, U.S. Naval Air Systems Command, P.O. Dox 15036, Arlington, VA 22215; tel.: 202-692-7822; or G. Odam, Entopean Conrdinator, Royal Aircraft Establishment, Farnborough, Flants, GU14 5TD UK; tet: 0252-24461, cat. 2638.) (Sep. 6, 1983)

G. Odam, Entopean Conrdinator, Royal Aircraft Establishment, Farnborough, Flants, GU14 5TD UK; tel.: 0252-24461, cat. 2638.) (Sept. 6, 1983)
June 26-28 International Symposium on Deep Structure of the Continental Crusti Results from Reflection Scisumbogy, Ithaca, N.V. Sponsors: Cornell Univ. Institute for the Study of the Continents, AGU, GSA, IASPEI, International Lithosphere Program, SEG. (Muswia Darazangi, Conference Goordinator, Oept. of Geologial Sciences, Connell Univ., Ithaca, NY 14853; tel.: 607-250-0411 or telex: 937478.)
June 26-29 WRI-DIDE Tar Sand Symposlum, Vall, Colo. Sponsors: Western Research Institute, U. 5. Department of Energy, tl. C. Marchan, Western Research Institute, P.O. Box 3995, University Station, Laramie, WY 82071; tel.: 307-721-2203.1 (June 5, 1984.)
July 2-5 Symposium on the Physics of the Magnetosphere-lonosphere Connection, Graz, Austria. Sponsor: Connuittee un Space Research of ICSU. (E. R. Schnierling, EE-8, NASA Headquarters, Washington, DC: 205-16.) [Dec. 6, 1985.)
July 5-5 Second Symposium on Plasmo Double Layers and Related Toples, Innsbruck, Austria. (R. Schriftwieser, Inst. for Theurell-cal Physics, Univ. of Innsbruck, Sillgasse 8, A-6020 Innsbruck, Austria.)
July 9-15 Inconstional Symposium on Space Techniques for Geodeynamics, Supron, Istingary, Sponsors: Hungarian Academy of Sciences and IAC/CO51AR Joint Commission on the International Councilisation of Space Techniques for Geodesy and Geolynamics. ICh. Reigher, Dentsches Leoditisches Forschungsinstian, Akt. 1, Marstaliplatz 8, D-8000 Munich 22, FRG.)
July 9-15 Looglude Zoco, Greenwich, UK. Sponsors: International Union for the History and Philosophy of Science and the International Astronomical Union, IConference Officer, "Longitude Zero" Symposium, National Maridme Museum, Creenwich, London SEO 9NF, UK.) (Nov. 15, 1983.)
July 10-14 The Case for Mars II, Boulder, Cole. Sponsor: Mars Institute of the Planetary Society. (Helen Han, Laboratory for Atmespheric and Space Physics, Univ. of Colorado, Soulder, Cole. Sponsor:

Stoker or Tom Meyer, Case for Mara, P.O. Box 4877, 8 oulder, CO 80806; tel.: \$03-494-8144.) (Dec. 20, 1983.) July 18-20 Seismic Deconvolution Workshop, Vall, Colo. Sponsor: SEC. (Sven Treitel, P.O.

July 18-20 Selamic Deconvolution Workshop, Vall, Colo. Sponsor: SEC. (Sven Treite).
Amoco Production Co., Research Center, P.O. 80x 591, Tulsa, OK 74102.) [Feb. 7, 1984.)
July 19-25 Symposium on Wave Breaking.
Turbulern Mixing, and Radio Probing of the Ocean Surfaco, Sendai, Japan. (O. M. Phillips, Dept. of Earth and Planetary Sciences, Johns Hopkins Univ., 8 altimore, MD 21218; iel.: 301-358-7036.)
July 21-28 Eighth World Conference on Earthquake Engineering, Sen Francisco. Sponsor: Earthquake Engineering Research Institute. (J. Penzin, Earthquake Engineering Research Institute, 2620 Telegraph Ave., Berkeley, CA 94704; iel.: 413-848-0972.)
July 23-24 Eastern Regional Groundwater Conference, Newton, Miass. Sponsor: National Water Well Association, Miass. Sponsor: National Water Well Association, 500 W. Wison 8 ridge Rd., Worthinglon, OH 43085; iel.: 614-846-9355.)
July 23-25 Summer Compoter Simulation Conference, Doston, Mass. Sponsor: Society for Computer Simulation. (W. D. Wede, 1984 SCSC Program Chalrman, Wode Engineering P.C., P.O. Box 849, Hundington, NY 11743; july 23-26 11th International Symposium on Urban Hydrology, Hydraulics, end Sediment Control, Lexington, Ky. Sponsor: Univ. of Condinuing Education/Engineering, 223
Transportation Research Bidg., Univ. of Kentecky, Lexington, KY 40506-0045; iel.: 606-1047, 123-27 International Symposium on Chal-

lenges in African Hydrology and Water Resources, Harare, Zimbabwe, Sponsors: 1AH5, UNEST; O. Whil). (Zimbabwe, Sponsors: 1AH5, UNEST; O. Whil). (Zimbabwe, Conference Board, P.O. Box A585 Avondale, Harare, Zimbabwe; 1el.: 308222; telex: 4-285 ZW.] July 24-26 Water Rights Specialty Uniterence, Flaguaff, Ariz. Sponsors: Ground Water Committee and Surface Water Committee of the A512 Urigation and Drainage Division. (Kenneth G. Renard, Southwest Watershed Research Center, 2000 E. Allen Rd., Tucson, AZ 85719; tel.: 602-620-6381.) July 26-27 A Joint Warkshop of the Committee on Climatic Changas and the Ocean and the Joint Scientific Committee for Warld Climato Research Panel, Sendai, Japan. (O. M. Phillips, Dept. Earth and Planetery Sciences, Johns Hopkins Univ., Baltimore, MD 21218; tel.: 301-338-7036.)

iel.: 301-338-7036.)
July 29-51 Conference on Educational Prerequisites for Water Resources Management,
Daton Rouge, La. 5pnnsor: Universities Council on Water Resources. IYacuv Haimes,
Chairman, 5ystems Engineering Dept., Case
Institute of Technology, Case Western Reserve Univ., Cleveland, OH 41106; Jel.: 216368-4492.)
July 80-August 2 Seminar on Water Management

mara or jack Grittin, Nava Uniterwater Systems Center, New London, CT 06320; tel.: 203-440-4590 or -1116.]

June 25-27 Rack Mechanics in Protection onl Productiviry, 25th U.5. Symposium on Rock Mechanics, Evanuton, Ill. Sprason: AGU. (Charles H. Dowding, Dept. of Civil Engineering, Northwestern Univ., Evanston, Il. 60201; tel.: 312-492-7270.1 [Sepr. 13, 1983.]

June 25-29 Gordan Research Coofsrence an Environmental Sciencesi Water Interfiscial Processes, New Hampton, N. H. (Alexander M. Cruickshank, Director, Gordon Research Conferences, Univ. of Rhode Island, Kingston, Rt 02881-0801; tel.: 401-783-4011 or 401-783-3372.) [April 17, 1984.]

June 25-29 Gordon Research Conference on Research at High Pressore, Merislen, N. H. (Alexander M. Cruickshank, Director, Gordon Research Conferences, Univ. of Rhode Island, Kingston, Rt 02881-0801; tel.: 401-785-4011 or 401-783-3372.) (April 17, 1984.)

June 25-July 7 ICSU Committee ao Space Research Conferences, Univ. of Rhode Island, Kingston, Rt 02881-0801; tel.: 401-785-4011 or 401-783-3372.) (April 17, 1984.)

June 25-July 7 ICSU Committee ao Space Research Zohmete Stience & Osrd., H-828, National Academy of Sciences, 2101 Constitution Acc., N.W., Washington, DC 20418.)

June 25-July 7 Symposium on Space Observations for Climate Studies, Graz, Austria.

Sponsor: World Climate Program, (S. Ruitenberg, Secretary, CO5PAR Commission A, NCAR, Boolder, CO 80307.) (July 19, 1983.1 June 20-88 Symposium of the Achievements of the Internadonal Magnetospheric Study, Graz, Austria, 5 ponsor: 1C5U Scientific Committee on Solar-Terrestrial Physics. (J. G. Rocder, Geophysical Institute, Univ. nl Alatka, Faithanks, Ak 9070t.)

June 28-28 1984 International Conference on Ughtotag sod Starle Electricity, Orlando, Fla. 5 ponsors: NOAA, 1EEE, SAE-AE4 Committee, and severat military and civilian air transpertation agencies in the U.S. and UK. serve Univ., Cleveland, OH 41106; iel.: 216-368-4492.)
July 80-August 2 Seminar on Water Management Practice, Zeria, Nigeria. Sponsors: International Association for Hydraulic Research and UNESCO. [Gunnar Lindh, Dept. of Water Researces Engineering, Lund Institute of Trch., Fack 725, S-220 07 Lind, 5weden.) [Dec. 6, 1983.)
July 30-August 5 Eurogeophysics Assembly, Louvain-la-Neuve, 8elgium. Sponsors European Geophysical Society. (G. M. Drown, Dept. of Physirs, Univ. College of Wales, Aberystwyth, Wales, UK.) (Drc. 20, 1985.)
July 31-Aug. 2 Fourth International Sympasium on Stochastic Hydraulics, Univ. of Illinois, Urbana-Champaign. Sponsors: IAHR and AGU. [Ben C. Yen, Wilson H. Tang, ar Glenn E. Siout, Dept. of Civil Eng., Univ. of Illinois, 208 N. Romine St., Urbana, IL. 61801; iel.: 217-333-0687 or 353-0536.] [Nev. 8, 1988.)

B. 1983.)

July 31-August 3 Workshop on Fisuloo Track Dating, Troy, N. Y. Sponsors: General Electric R&D Lab., 5 UNY at Albany, and Renselaer Polyrechnic Institute. Donald S. Miller, Dept of Geology, Rensselaer Polyrechnic Institute, Troy, NY 12181.)

Aug. 4-14 27th International Geological Congress, Moscow, USSR. Sponsors: USSR National Committee for Geology, IUGS. (Organizing Committee of the 27th IGC. Institute of the Lithosphere, 22, Standardenty, Moscow, 109180, (ISSR.)

Aug. 6-9 Chapman Conference on the Magnetispheric Polar Cap, Fairbanks, Aloska, Polar Cap Meeting, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.) (Jan. 24, 1984.)

Aug. 12-17 20th Annual AWRA Conference and Symposium, Washington, D. C. (Arlene

and Symposium, Washington, D. C., (Arlene Dictz, U.S. Army Corpy of Engineers, Insti-tute for Water Resources, Casey Bldg., Fort Belyoir, VA 22080; tel.: 703-355-2368, (Acq., 1992)

Belvoir, YA 22000; tet.: 703-2505-25054 (Aug. 16, 1983.)
Aug. 18-17 Gurdan Research Conference on Chemical Oceanography, Meriden, N. H. Chairman: William Sackett, (Alexander M. Cruickshank, Director, Fordon Research Conferences, Univ. of Rhode Bland, Kingston, RI (2004) 1804-181, adv. 401-783, 401-128. ferences, Univ. of Rhode Island, Kingston, RI 192881-19801; tel.: 401-783-4011.) Aug. 13-17 12th International Laner Radar Camference, Aix-en-Provence, France, Spon-sors: IAMAP and AMS, IC. Megic or J. F. Granien, Servace D'Aeronomic du CNRS, 12th International Laser Radar Conference, BP 3, 91370-Verrieres le Butwon, France (12-0) 8, 1983.

Aug. 1:1-17 Specialty Conference on Water for

Aug. 1-17 Specialty Conference on Water for Resource Development, Cacuir d'Alenc, Idalio. Sponsor: Hydraulics Olvision of ASCE. Harry Twel, American Society of Givil Engineers, 345 E. 47th 51. New York, NY 10017–1398; 1cl.: 212-705-7494.)

Aug. 15-17 Conference on Practical Applications of Groundwater Models, Columbus. Ohio. Sponsors: National Water Well Association, International Coundwater Modeling Center. IDavid Nielsen. Conference Coordinator, National Water Well Association, Online Bridge Rd., Worthington, OH 43085; Icl.: 514-8-69-955.]

Aug. 19-22 Pathways and Puture Directions for Ecylronnental Data and Information Users, Detiver, I'olo. Sponsor: NOAA. (5E5, Incorporated, I'.O. Box 2f:97, Springfield, VA 12(152.) (June 5, 1984.)

Aug. 20-21 Govdon Research Conference on Organic Geochemistry, Plymouth, N. H. Chairman: Keith Kvenvolden: Jaleander M. Crnickslinnk, Director, Cordon Research Conferences, Univ. of Rhode Island, Kingston, RI 928B1-0301; 1el.: 401-783-4011.)

Aug. 21-29 International Radiation Symposium '84 (IRS), Perugia, Italy. Sponsor: IA-MAP Radiation Commission: [Giorgio Fiococ, Chairman, IRS '84, Dipartimento di Fisica, Città Universitaria, 00185 Rome, Italy; telea: INFNRO 613255.)

Aug. 22-26 Field Conference on Open System Behavior in Magnantic Evolution: Petrological, Ceochemical, and Geophysical Constraints, Taos, N. Mex. Sponsor: Insulnite for the Study of Earth and Man. [Mike Dungan, Dept. of Geological Sciences, Southern Methodsis Univ., Dellas, TX 75275; 1cl.: 214-692-2750.) (Jan. 17, 1984.)

Aug. 26-29 Geothormal Resources Council 1984 Annual Meeting, Reno, Nev. (Geothermal Resources Council, P.O. 80x 1830, Davis, New 1984 (1984), 1984.)

odisi Only, Danias, 13, 79275, Ich. 210022
2750.) (Jan. 17, 1984.)
Aug. 26-29 Geothormal Resources Council 1984 Annual Meeting, Reno, Nev. (Geothermal Resources Council, P.O. 8 ox 1950, Davis, CA 99617; Ied.: 910-758-2980.) [Feb. 7, 1984.)
Aug. 26-31 Seventh Australian Geological Convention, Sydney, Australia. Sponsor: Geological Society of Australia. (Secretary 7 ACC, P.O. Box 385, North Ryde, NSW, Australia 2113.) (Nov. 29, 1983.)
Aug. 27-31 Seventh IAHR Symposium oo Ice, Hamburg, Germany. (J. 5chwart, Ice Engineering Div., Hamburgische Schiffbau-Versuchanstalt CmbH., P.O. Box 000 929, 2000 Hamburg, FRC.) (Nov. 22, 1983.)
Aug. 27-Sept. 6 General Assembly of URSI, Florence, Italy. (Vitic Cappellini, IROE, Via Panclatichl 64, 50127 Firenze, Italy.) (Dec. 27, 1983.)
Aug. 20-31 Symposium on the Physics of Shallow Estuartes and Baya, Mlami, Fia. Sponsors: ASCE Coastal Engineering Research Council, Rosenstel School of Manine and Atmospherie Science, (Physics of Shallow Estuaries and 8 ays. (of Division of Ocean Engineering and Applied Marine Science, RSMAS, Univ. of Miami, 4600 Rickenbacker Causeway, Mismi, Fl. 33149; tel.: 305-361-1160.)
Sept. 3-7 Quadrennial Ozone Symposium, Halkidtki, Greece. Sponsors: IAMAP International Ozone Commission (IOC), Commission of the European Communities, the Academy of Athers, and WMO. (Christos S. Zerofos, Chairmen, Local Organizing Committee, Physics Dept., Campus 8 ox 149, Univ. of

of Atheru, and WMO. (Climbos Atheru, and WMO. (Climbos Atherus, Local Organizing Committee, Physics Dept., Campus Box 1-19, Univ. of Thessaloniki, Thessaloniki, Creece. Send copy of Information request to C. D. Walshaw, Secretary, IOC, Clerendon Laboratory, Oxford Univ., Parks Rd., Oxford, OXI BPU, UK.)

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Chapman Conference on Vertical Crustal Motion: Measurement and Modeling

A Chapman Conference on Vertical Crustal Motion: Measurement and Modeling will be held October 22-26, 1984, in Harpers Ferry, West Virginia.

Convenor: William E. Strange

This conference will bring together scientists who measure vertical crustal motions and those who analyze and model these motions with the primary objective of obtaining cluse interaction between the two groups. Emphasis will be on vertical crustal movement in North America. Questions to be addressed will be (1) what are the accuracies and error sources associated with each data type? (2) What is the exient of the current data base? (3) How accurately do we know vertical crustal motions in North America? (4) What are realistic expectations of contributions from space systems and other new technologies in the next decade? (5) What is the current status of modeling vertical crustal motions? (6) How important is vertical motion information to understanding and modeling earth dynamics? (7) What are the measurement requirements to support modeling and analysis in terms of temporal and spatial density and accuracy? (8) What are the most critical deficiencies of vertical motion data relative to modeling and analysis?

There will be invited and contributed presentations. The Call for Papers was published in the March 20, 1984, issue of Eos. Abalract deadline is August 1, 1984. Abstracts should be submitted to the American Geophysical

For Information on the regulred abstract formal or further meeting logistics, contact:

AGU Meeting Department 2000 Florida Avenue, N.W. Washington, DC 20009 (202) 462-6903

For program information contact: Dr. W. E. Strange NOAA/NOS/CNGS/NGS/N/CG11 6001 Executive Blvd. Rockville, MD 20852 (301) 443-2520



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ter Quality Management Modeling, Hamil-ton, Ontario, Canada. (William James, Givil Engineering Department, McMaster University, Hamilton, Ontario, Canada, L8S 41.7.)

1y, Hamilton, Onterio, Canada, L8S 41.7.)
(June 5, 1984.)
Sept. 9-14 Penrose Conference on the Geochemistry of the Environment Near n High-Level Nuclear Waste Repository, Mt. Hood, Oreg. Sponsors: Ceological Society of America, Nuclear Regulatory Commission. (David Coles, Battelle Pacific Northwest Laboratories, P.O. Box 999, Richland, WA 08352.) (May 15, 1084.)

P.O. Box 999, Richland, WA 08352.) (May 13, 1084.)
Sept. 9-14 American Society of Photogrammetry/American Congress on Surveying nod Mapping Pall Technical Meeting, San Antonio, Tex. [Monica Milain, 1984 ASP-ACSM Fall Convention, P. O. Box 8172, San Antonio, TX 78208.)
Sept. 10-12 Seventh Annual Madison Conference of Applied Research on Munlelpsi and Industrial Wasto, Madison, Wis. (Philip R. O'Lesry, Dept. of Engineering and Applied Science, Univ. of Wisconsin-Extension, 432 North Lake St., Madison, WI 53708; tel.: 608-262-0498.)
3ept. 10-12 Oceans 84 Conference and Exhibition, Washington, D. C. Sponsora: Marine Technology Society, AGU, and Institute of Electrical and Electronics Engineers/Oceanic Engineering Society, IOceans 84 Technical Program Committee, 1730 M St. N.W., Suite 412; Washington, DC 26030.) [Now. 29, 1988.)
Sept. 10-14 International Symposium on Hydromechanical Balances of Fresh Waitr Sys-

tema, Stockholm/Uppsata, Sweden. Sponsors: Swedish Natural Science Research Council. UNESCO, and IAHS. (M. Falkenmark, Exec. Sec. NFRS, Coinm. for Hydrology, Box 0711, S-11385 Stockholm, Sweden.)

Sept. 12-14 Seminar on Degradation, Retention, and Dispersion of Poliutants in Groundwater, Copeuhugen, Denmark. Sponsor: International Association on Vater Poliution Research and Control. Erik Arvin, Dept. of Environmental Engineering, Building 115C, Technical Univ. of Dennierk, Dk-2800 Lyngby, Denmark.) (Dec. 18, 1983.)

Sept. 20-21 International Symposium on Environmental Poliution, Site To Be Announced. (V. M. Bhatnavger, Box 1779, Cornwall, Ontariu K6H 5V7, Camada.)

Sept. 24-25 Seminar: Enhanced Biological Romoval of Phosphorus From Wastowater, Paris, France. Sponsor: International Association on Water Poliution Research and Control. (Michel Florentz, Phosphorus Seminar, Anjou-Rechorche, S2, Rue d'Anjou, 75984 Paris Cedex 08, France; Tel.: 266-91-SB; telex: Geneaux 280 382 F.) (Sept. 6, 1985.)

Sept. 24-26 International Water Well Exposition, Las Vegas, Nev. Sponsor: Netional Weter Well Association, 900 W. Wilson Bridge Rd., Vorthington, OH 48085; tel.: 614-846-9855.)

Sept. 24-28 SLEADS (Soli Lakes, Evapontes, Aeolian Deposita) Workshop on Canosole Salt Lakes and Arld Zone Flydrology, Ceochemis-

Meetings (cont. on p. 388).

5121.)
Sept. 28-20 Tectonic Gromorphology—15th
Aa auai Geomorphology Symponiuto, Binghamton, N.Y. Organizers: Marie Morisawa
and John Hack. Taltacic Morisawa, Dept. of
Geological Sciences, SUNY, Binghomion, NY
13901: tel.: 607-798-2015.)

13901; tel.: 607-798-2015.)

Oct. 1-5 laternational Sympositiat on Recent Lavenigations in the Zone of Aeration, Munirh, FRG. Spontor: Technical Univ. of Munich. (P. Uditalt, RIZA Symposium, Institut für Wassercheaue tier TU Münrhen, Marchimibit., 17, 1)-8000 Monich 70, FRG.)

climmiut. 17, 1)-8000 Monicle 70, FRG.)
[Dec. 20, 1983.]
Ott. 1-6 European Seismologieal Commission, Mosrow. (Organizing Committee, ESC, Soviet Ceopliysical Committee, Moloderhnaya 3, 117 296 Moscow, USSR.]
Oct. 3-S 1984 Arcile Seirace Goaference (35th Alaska Science Conference), Anchorage. Alaska. Spunsnr: AAAS Arcile Division. (John Davles, P.O. Bax 80271, Fairlanaks, AK D9708; pd.: 907-274-7371.) (May 1, 1984.)

Davies, P.O. Bax 80271, Fairbonks, AK
09708; rel: 907-474-7371.) (May 1, 1984.)
Oct. 3-5 Symposium in Meleocology sad
Oceanegrophy of Northeen High Laftudes,
Anchinage, Alaska, Spiriture: American Meleoridogical Society and AAAS, (Shari Bigher,
National Weather Service, 701 C St., P.O. Box
23, Anchonage, AK 99513. 1 March 6, 1984.)
Oct. 8-10 Hill A mitual Association of Earth
Science Editors Conference, Poutland, Oreg.
(Astociation of Earth Science Edition, 4220
King St., Alexandria, VA 22302.1
Dt. 8-11 World Conference on Remote Sensing, Baytenth, FRG, Spinisori: Unic of Bayreuth, Texas Christian Univ. Center for Earth
earth onnental Chemists. (Lear W. Newland,
Director, Environment Sciences Program,
Texas Christian Univ., Fost Worth, TX
76129, iel.: 817-421-7271.1 (Feb. 7, 1984.)
Oct. 9-12 Hill Annual Meeting of the Divislon for Planetary Science of the American
Astronomicol Soriety, Kailma-Kona, Hawaii
Sponsors: the Hawaii Institute of Geophysics,
Univ. of Hawaii, 2525 Coytea Roan, Honolula, 111 96822. 1 Lawaii Institute of Geophysics,
Univ. of Hawaii, 2525 Coytea Roan, Honolula, 111 96822. 1 Papril 24, 1984.1
Oct. 10-12 Seismologien Society of Ameeles
Eastern Section 56th Annual Meeting, St.
Loois, Mo 18obert B. Herrmann, Cept. of
Earth and Atmospheric Sciences, St. Louis
Univ., FO. Box 8039, St. Louis, Mo 63156;
161:314-638-3120.1

tel.:314-658-3120.4
Oct. 10-13 New Mexico Geological Society
35th Annual Field Conference, Taos, N. Mex.
1R. Riccker, General Chairman, Los Alamos
National Laboratorr, Marl Strap O4th, Earth
and Space Sciences Div., Los Alamos, NM
87845. 1Nov. 1, 1983.)
Oct. 13-16 Conference on the Origin of the
Moon, Kona, Hawai. Sponsors: Lunay and
Planetory Institute, Division for Planetary Sciences of the American Astronomical Society.
(Pam Jones, Lunay and Planetary Institute.)

enres of the American Astronomical Society.

(Pam Jones, Lunar and Planetary Institute, 3303 NASA Road I, Hutston, TN 7705B.1

Oct. 15-17 First Multidisciplinary Conference on Sinkholes, Orlandn, Flo. Sponsors: Florida Sinkhole Research Institute, University of Central Florida. Barry Beck. Director, Flerida Sinkhole Research Institute, College of Engineering, Univ. of Centrel Florida. Orlando, FL 32816, tel.: 305-275-2043-1

Oct. 15-21 IGC.P Project 19B: Evelution of the Northern Margin of Tethyn, Braislava, Gzecheslovakia. Spontor: International Geological Correlation Programme, Islam Nairn, ESR1, Univ. of South Caeolina, Columbia, SC 29208.1

ESRI, Univ. of South Caeolina, Columbia, SC 29308.1

Oct. 16-18 Statistics Sympositud on National Energy Issues, Seattle, Wash. (Robert Kinnison, Statistics Section, Pacific Northwest Laborators, P.O. Box 999, Richlansl, WA 99352.)

Oct. 16-19 International Symposium on Lake and Waterched Managements Local Involvement, McAfee. N.J. Sponsur: North American Lake Management Society. (Harry Gibbons, Jr., Dept. of Civil and Environmental Engineering, Washington State Univ., Sloan Hall 141, Pullmon, WA 99164-2912.) (Morch 8, 1988.)

1984.)
Oct. 17-19 AIPG Annual Meeting, Orlando, Fla. (Robbs, J. Timmons, General Chairman, Timmons, Asswintes, P.O. Box 50506, Jacksonsille, FL 32230; tol.: 904-246-4535.)
Oct. 17-19 CRREL/ARO Workshop nn the Interaction of Rudsr with the Seasonal Snow Cover, Cold Regions Research and Engineering Laborators, Hanover, N. H. Sponsors: CRREL, AGU Hydrology Section, IS. C. Culbeck, FRREL, 72 Lyme Ruad, Hanover, NH 03755.)

Oct. 22-26 Ghapman Conference on Vertical Oct. 22-26 Ghapman Conference on Vertical Crustal Motiont Measurement and Modeling. Harpers Ferry, W. Va. Sponaor: AGU, 1Vertical Motion Meeting, AGU, 2010) Florida Ave., N.W., Washington, Dr.: 20009; (deplume 202. 462-6003 oc trill-tice RRI--121-2188.)
Crt. 28-30 | Eth Underwater Mining Institute, Madrinn, Wis. (J. Rubert Minine, Pingram Chairman, Univ. of Texas at Augin, Marine Science Institute, 200 East 20 128 L., Augin, TX 78705; (el.: 512-471-4816.)
Crt. 29-30 | Cimierence on Methods foe Evaluation of Groundwater Contamination Sites, East Larring, Mich. Spanson: Michigan Dept. of Natural Resourcet, Michigan State Univ., USGS. (D.), et al. Hanilton, Michigan Dept. of Natural Resourcet, Michigan Dept. of Natural Resourcet, Seevens T. Mason Building, Box Still28, Lansing, Mi 48909.)
Crt. 30-Nov. 3 | Symposium on Relationships Between Glimmte of Ghinn and Global Glimate—Past, Present, and Future, Peking, China. Sponsors: Academia Sinka, International Association of Meteorology and Atmospheric Physics (JANAP), American Meteorological Society, (Jih-Ping Chao, Justilute of Atmospheric Physics Academia Sinka, Languageling, Chi-

spheric Prints, Academia Sinca, Zeijing, Gran, A. (March 27, 1984.)
Oct. 31-Nov. 7 Regional Asserably of IA-SPEI, Hyderabad, India. (Mohan L. Gupto, Organizing Committee, IASPEI Regional Astembry, Notional Geophysical Research Institute, Hyderabad-500 007, India; telex: 155-478 NGR1 IN; cable: Geophysics.) (Aug. 28, 2008.)

1988.) Nov. Mexicao Goophyalcai Union Aonual Meeilng, La Paz, Baja California Sur, Mexico. Union Geofisica Mexicana, A.C., Comite Or-

gaalzador Reiinlon 1984, Apariado Postal 1805, Ensenada 22800. B.C.N. Mexico.)
Nov. 5-8 GSA Annual Meeting, Reno, Nev. (Jean Laudippe, GSA, P.O. 8nx 9140, Boulder, CO 80301; rel.: 303-447-2020.)
Nov. 8-9 Illinola Lake and Watershed Massegeioeni Confere nee, Springfield, Ill. Sponsors: University of Illinois Water Resources Ceatar, AWRA Illinois section, North American Lake Management Society. IGlenn Stout. Water Resources Centar, Univ. of Illinois at Urbana-Champaign, 2535 Hydrosystems Laboratory, 208 North Romine St., Urbana, IL 81801; ed.: 217-333-0536.]
Nov. II-16 Engineering Foundation, Santa Barbara, Calif. Sponsors: The Eagineering Foundation, Universities Council on Water Resources. (Engineering Foundation, 345 E. 47th St., New York, NY 10017; tel.: 218-705-7835.)

Resoueces. (Engiaeering Foundation, 345 E.
17th St., New York, NY 10017; tel.: 212-7057835.)

Nov. 12-17 Water for South Africa, Johannesburg, South Africa. Sponsors: Notional Woter
Well Association and the Borehole Water Association of Southera Africa. (David M. Niclsen, Conference Coordinator, NWWA, 500
W. Wilson Bridge Rd., Worthington, OH
43085; trl.: 614-846-9355.) [Dec. 13, 1983.)

Nov. 1S Conference on Water Reuss and Desalinsilon, Johannrsbueg, South Africa. Spoasor: National Water Well Association. (Pat Alcom, NWWA, 500 W. Wilson Bridge Rd.,
Worthington, OH 43085; tel.: 614-846-9355.]
(May 29, 1984.)

Nov. 13-15 Ophiolites Through Time, Nancy,
France. (Jacqueline Desmons, Université de
Nancy I, Faculté des Sciences, Laboratoire de
Pétrologie, B.P. no. 239, F-84500 Vandoeuvre-lès-Nanry Cedex, France.]

Nov. 28-30 WMO Technical Conference on
Urbaa Climstology and its Applirations With
Special Regard to Tropical Acoas, Mexico
City, Spontors: World Meteorological Organitatios, World Health Organization, 41, Ginseppe-Motta, Case pustale Nn. S, CH-1211
Geneva 20, Switzerland.)

Nov. 26-30 Symponium on the Srientific Basiu
for Nuclear Waste Managemeat, Buston,
Mass. 3pontor: Materials Research Society,
(John Stone, E. I. the Pont de Neinours and
Cu., Savannah River Laboratory, Alken, SC
29808.) (May 8, 1984.)

Nov. 27-30 Thirtieth Annuol Conference on
Magnellsm and Magnelle Moterists, Saa Diego, Calif. Sponsora: Anteriaan Institute of
Physica, Magnetics Society of IEEE (John
Scott, American Institute of Physics, 335 East
45th St., New York, NY 10017.) (June 5,
1984.)

Dec. 3-7 AGU Fall Messlog, San Francisco.

45th St., New York, NY 10017.) (June 5, 1984.)

87 Dec. 3-7 AGU Fall Mestlog, San Francisco. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC: 20009.)

Dec. 16-21 International Chemlest Congress of Pacific Batin Societies, Honolulu, Hewaii. Sponsors: ACS, Chemical Institute of Canada and Chemical Society of Japan. (PAC CHEM '84, Meetings and Divisional Activities Dept., ACS, 1155 164t. St., N.W., Washington, DC 20036; tel. 202-872-1996; PAC CHEM '84, Chemical Institute of Canada, 151 Slater St., Suite 906, Ottawa, Omario K1P 5H3, Canada, tel.: 613-235-5623; PAC CHEM '84, Chemical Society of Japan, 1-5, Kanda-Suntgadai.

tel.: 613-233-5623; PAC CHEM '84, Chemical Society of Japan, 1–5, Kanela-Suntgadai, Chiyoda-ku, Trikyo ltil, Japan; tel.: 03-292-6161.) (Sept. 13, 1983.)

Drc. 28-31 Fortith International Conference on Applied Numerical Modeling, Taiman, Taiwan, 15, V. Wang, School of Engineering, Univ. of Mississippi, University, MS 38677; tel.: 801-232-7219.]

Jan. 7–12 17th International Congress on Hydrogeology of Rocks of Low Permeability, Tucson, Ariz. Sponsors: International Association of Hydrogeologists, AGU. (E. S. Simpson, Dept. of Hydrology ond Water Resources, College of Engineering, Univ. of Arizona, Tucson, AZ 85721.)
Feb. 21–22 Sixueenth Annual Conference on Eroslon Control Practices and Research, San Francisco, Sponsor: International Erosion

Feb. 21-22 Sixuemih Annual Conference on Ecosion Control Practices and Research, San Francisco. Sponsor: International Erosion Control Association. iCerry Hester, Program Control Association. iCerry Hester, Program Control Association, Inc., P.O. Box 807. Freedom, CA 95019.1 (May 29, 1984.)

Maich 10-15 American Society of Photogremmetry and American Gongress on Surveying and Mapping National Meeting, Washington, D. C. (Wildord A. Kunciu, 4415 Jensen Pl., Fairfax, VA 22032; ed.: 705-423-8790.)

March 11-15 Sixteeuth Lunar and Planetary Science Conference, Houston, Tex. Sponsers: Lunar and Planetary Institute, AGU, NASA Jehnson Space Center, Division for Planetary Science of the American Geological Society of America, Meteoritical Society. (Pamela Jones, Conference Administrator, Lunar and Planetary Institute, 3303 NASA Road I. Houston, TX 77058; etc.: 713-486-2150.]

April 1-1 Europesa Union of Geosciences Biennial Meeting, Strasbourg, France. (Organizing Committee, Dept. of Earth Science, Univ. of Cambridge, Downing St., Cambridge CB2 3FQ, UK.)

April 9-11 Fifth Annual Front Range Branch Hydrology Days, Fon Collins, Colo. 1H. J. Morel-Seytoux, Dept. of Civil Engineering, Colorado State Univ. Fort Collins, CO 80523; rel.: S03-491-5448 or 8549.)

April 14-19 GSA Pearose Conference on Geomorphic and Stratigraphic Indicators and Nea-

pril 14-19 GSA Pearose Contenence on Geo-morphic and Strangraphic Indicatore of Neo-geoe-Quaternsry Climaile Change in A rid and Semiarid Environments, Lake Havasu City, Arir. Camveners: John Dohrenwend, USGS; Steve Wells and Les McFadden, Univ.

USGS; Sieve Wells and Les McFardten, Univ. of New Mexico. (John Dohrenwend, U. S. Geoingical Sorvey, MS 911, 345 Middlefield Rd., Menio Park. I:A 94025.)

April 15-19 First International Symposium on Precise Pontitoning with the Global Positioning System, Rockville, Md. Spunsors: IAC, IUGG, Delense Alapping Agency, NOAA. (Positioning with 1iPS-1985, White Fifm Mall, Pon Office Hox 2095, Kenslagton, MD 2089S.)

For Office Hox 2095, Kenslagion, MD 20805.)

April 21-26 Third International Symposium on the North American Verilral Dalum, Rockville, Md. Sponsors: IAG, NOAA, National Geodelic Survey, IGary M Young, Ass. Director, NAVD Symposium 85, White Film Mail, P. O. Box 2065, Kensington, MD 20895; Icl. S01-443-8587.]

April 28-May I laternational Conference on Arelle Water Pollotion Research Applications of Science and Technology, Vellowknife, Northwest Territonics, Canada, Organizer: Canadian National Committee, International Association on Water Pollution Research and Control, (K. Charbonneau, National Research Council of Canada, Montreal Road Laboratories, Ottowa K1A OR6, Canada; Icl.: 813-993-9009.)

April 30-May I Symposium on Watershed Management, Benver, Colo, Sponsor: American Society of Civil Engineera. (E. Bruce)

(A), Dan Winske (SM), A. Michelle Wood (O), P. Jane Wynne (GP), Richard Yuretich (H).

Jones, President, Resource Coasultants, Inc. P.O. 80x Q. Furt Collins, CO 80522. (May 1,

P.O. 80x Q. Furi Collins, CO 80522.1 (May 1, 1984.)

88 May 27-31 AGU 8 pring Meeting, Baltimore, Md. (Meetings, AGU, 2000 Florida Ave... N.W., Washington, DC 20009-1.

Summer Colloquium on Comparative Study of Magnetospheric Systema, France, IDominique Le Quédu and 8 ent Mooller-Pedersen, DASOP, Observatoire de Meudoa, F 92105, Metidon Principal Cedex, France; Telex: 200 590 CNET 085.1 (Aug. 9, 1983.)

June 4-7 International Conference on Mafic Dyke Swarma, Missiasauga, Ontario. Sponsors: (UGS Commission on Tectonics, the International Lithosphere Programme, and the Geological Survey of Canada. (H. C. Halls, Erindale Campus, University of Toronto. Missiasauga, Oatario, Canada LbL 1 CG; tel.: 416-828-3505.)

June 9-15 IWRA Fifth World Congress, Britssels, Belgium. (Flith World Coagress On Woter Resources, Brussels International Conference Centre, Parc des Expositions, Teniconstellingspark, B-1020 Brussels, Belgium; tel.: 32-2478-48-60; telex: 23-643.1 (Aug. 30, 1983.)

ence Centre, Parc des Expositions, Tenioonstellingspark, B-1020 Brussels, Belgium; 1el.:
32-2-478-48-60; telex: 23-643.] (Aug. 90,
1983.)

Juae 16-21 Third International Symposium
on Analysis of Selamicity and Selamic Risk,
Liblire, Czerhoslovakia, (Z. Schenkova, Geophysical Institute, Borni II, 14131 Prague 4,
Czechoslovakia, 2)

June 26-28 U.S. Synoposium on Rock Mechanirs, Rapid City, S. Dak. Sponsor, South
Dakota School of Mines and Technology. 1Eileca Ashworth, Chairman, 26th U.S. Symposlum on Rock Mechanics, Dept. of Mining Eagineering, South Dakota Srhool of Mines and
Technology, Rapid City, SD 57701-3995; tel.:
605-394-2344.]

July 8-10 laternotional Hydrology Symposium, Fort Collins, Colorado. Sponsors: AGU
Hydrological Sciences, ASGE, 1WRA,
IAHR, (H. W. Shen, Dept. of Civil Engineering, Hydrology and Water Resources Progrant, Foothilis Campus, Colorado State University, Fort Collins, CO 80523.)

July 29-Aug. 9 Tsunami 85: international
Taunami Symposium of the 1UCG Tsunami
Continission, Victoria, Causda. (Tsunami 85,
P.O. Box 2267, Sidney, B.C., Canada V8L
3S8; trl.: 604-658-8343.]

August International Worksbop on Hydrologle Applirations of Space Technology: Input
to Hydrologic Moriels and Ceographic Information Systems, Florids. Sponsors: IAHS,
WMO. (A. Ivoa Johnson, President, IAHS International Committee on Remota Sensing
and Data Transmission, 7474 Uphem Court,
Arvada, CO 80003.]

Aug. 5-10, 1985 IAMIAP/IAPSO Joint Scieniffic Assembly on the Large Sealo Circulations
of the Oreons and Atmosphere and their International Association of Geomagnetism and
Arronomy. (William J. Hurze. Dept. of Ceosciences, Purdue Univ., West Lafayette, IN
47907; tel.: 317-494-5982. (Feb. 7, 1984.)

Aug. 5-17 Symposium on Magoele Anomalies over the Margins of Continents and
Plates, Prague, Czechoslovakia. Sponsor, International Association of Geomagnetism and
Arronomy. (William J. Hurze. Dept. of Ceosciences, Purdue Univ., Nest Lafayette, IN
47907; tel.: 317-494-5982. (Feb. 7, 1984.)

Alendenholi, 12a South Oval Mail, Columbu OH 43210.)

Aug. 19-24 Fourth Chileon Geological Con-gress, Antologasta, Chile. Sponser: Dept. of Geosticiacs. Universidad del Norte. (Organ ing Committee, Fourth Chilean Geological

ing Committee, Fourth Chilean Geological Congress, Department of Geosciences, Universidad del Notte, Casilla (Box1 1280, Antofagasta, Chile; tal.: 222040-205.)

Aug. 19-30 23rd General Assembly of fA-SPEI, Tokyo, Japan. (Ryosouke Sato, Serretary-Ceneral of the 23rd Ceneral Assembly of IASPEI, c/o Inter Group Corp., Akasaka Yamakatu Bidg., 8-5-32, Akasaka, Minato-kiu, Tokyo 107, Japan; tel.: Tokyo (03] 479-531 1.]

Aug. 26-30 Internallonol Symposium on Geothermal Energy, Nailua-Kona, Hawaii, Sponsor: Geothermal Resources Council. (Coothermal Resources Council. (Geothermal Resources Council. (Geothermal Resources Council.) 20, 25617; tel.: 918-758-2360.)

September International Symposium on Varla-

September International Symposium on Varia-tional Methods to Geoselences, Norman, Okla. Sponsors: Cooperative Institute for Me-

auscale Meierstolugical Studies, Univ. of Okla-homa College of Geniciences, (V. R. Sasaki, Univ. of Oklahrana, 815 Jenkius, Norman,

Univ. of Oklahrona, 815 Jenkius, Norman, OK 73019.]

Sept. 16-21 Symposia on Potassic Volcanism and Ema Volcano, Catania, Italy. Sponsor: IAV(EL (G. Frazzetta and G. Lauzafame, Issimm Internazionale eli Vulkanologia, Vie R. Margherita, 6, Catania, Italy.) (Dec. 27, 1983.)

Sept. 17-21 APG Annual Meeting, 5t. Paul, Minn. (Robert E. Prendergast, General Chairman, Georechnical Engineering Corp., 1925 Oaktrest Ave., Roseville, MN 55113; tel.: 812-636-77444.)

Oakrest Ave., Ruseville, MN 35113; tel.: 812-636-7744.)
Ort. 9-10 International Symposium on Management of Hozardous Ghenileal Waste Sites, Winston-Salem, N. C. Spunsors: International Association of Engineering Geology U. S. National Committee, Association of Engineering Geologists. (Norman Tiltord, Dept. of Geology, Texas A & Al Univ., Callege Station, TX 77843-5115; tel.: 109-815-9182.)

77849-3115; tel.: 409-845-9682.)
Oct. 21-25 International Conference on Arid Landst Todoy and Tomorrrow, Tocson, Anz. Sponsors: UNESCO, Univ. of Arizona. (G. P. Nubhan, Office of Arid Land Studies, Univ. of Arizona, Tucson, AZ 85721.]
Oct. 28-31 Geological Society of Albertes 1983 Annual Meeting, Orlando, Fla. (Sue Beggs, Meetings Manager, GSA, P.O. Box 9140, Boulder, CO 80301; tel.: 303-447-9090.)

88 Dec. 9-13 AGU Fall Meeting, San Francisco. (Meetings, AGU, 2000 Finrida Ave., N.W., Woshington, DC 20009.1

Januory Symposium on Geoterhnical Applications of Remote Senaing and Remote Deta
Tronsmission, New Oricaus, La. Sponsor:
American Society for Testing and Materials,
(A. Ivan Johnson, Wexodward-Clyde Conseltants, Horlequin Plaza-Nurtht, 7600 E. Orchard Road, Englewootl, CO 80111; trl.: 503429-5610.]
April 21-24 International Symposium on Eovirontoental Geotechnology, Allentown, Pa.
(H. Y. Fang, Symposium Chairman, Ceotechnical Engineering Division, Dept. of Civil Engineering, Lehigh Univ. No. 13, Bethlehem,
PA 18015.]
May 18-21 International Symposium on Floed

PA 18015.]
May 18-21 International Symposium on Flood
Frequency and Risk Analyses, Baton Rouge,
La. (Vijay Singh, Louisiana Sante Univ., Dept.
of Civil Engineering, Bannt Renge, LA
70803-6403; tel.: 504-388-6697.)

70803-6405; iel.: 504-588-6697.)
June, 1986 Canference in Study and Miligation of Hazards, Sair Martin, Sponior: Tsuosmi Suciety. (Hazards Cartierence, 80x 60536, Las Vegas, NV 89160-1 (January 3, 1984.)
Sept. 7-12 Second International Conference on Paleoceanography, Woods Hole, Mass. (W. A. Berggren, Dept. of Geology and Geophysics, Woods Hole Occanographic Institution, Woods Hole, MA 02543.)

AAAS American Association for the Advancement uf Science AAPG American Association of Petroleum Geolo-

AND American Chemical Society
ALFG American Until the of Professional Geologist
AMS American Meteorological Society
ASCE American Society of Livil Engineers
AWRA American Valer Resources Association
GSA Feedingical Society of America
LAG International Association of Geometry
LAGA International Association of Geometry
and Agreements and Aeronomy IAHR International Association for Hydraulic Re-

1AHS International Association of Hydrological Sci-(AMAP International Association of Meteorolog) and Atmospheric Physics IAPSO (International Association for the Physical

IAPSO (international Association for the Physical Sciences of the Decart ASPET International Association of Sciencology and Physica of the Earth's Interior IAVCET International Association of Vukanology and Chemistry of the Earth's Interior ICSU International Caurnell of Scientific Unions IUCG International Union of Geodesy and Geoglobusts.

physics LUGS International Union of Geological Science LWRA International Water Resources Association MSA Mineratoglad Society of America SEG Society of Exploration Grophysicist SEJM Society of Exploration Grophysics and Ma-

erakogists URSI International Union of Radio Science WMO World Meteorological Organization

Membership Applications Received

Applications for membership have been received from the following individuals. The letter after the name denotes the proposed primary section affiliation.

Regular Members

Charles Andrews (H), Joanne Bourgeois (O), Eric L. Butler (O), Georgina Gantoni (T), George H. Garlson (H), Philip Carrion (S), Robert A. Gasde (G), Simon W. Ghang (Al, Mohammed El-Sabh (O), Sieven Emerson

Judy Fierstein (V), Leslie Gesell (A), David L. Glackin (A), Denise Graveo (A), Martin I. Hoffert (A), John Kanellopoulos (A), Jayne F. Knott (H), Nels R. Larson (A), Dong Soo Lee (O), Julian Marsh (V), Eric Medlin (T), Anne Meltzer (T).

Nitzan Rabinowitz (S), Young-Jae Ro (O), Jose M. Rodriguez (SA), Asbury H. Sallenger (O), Erwin Scheibner (T), G. P. Scofield (S), James V. Scrivner (V), Arni Snorrason (H), Robert Sterrett (H): Walter S. Urbanoki (V), Rutger Wahlstrom (S), Phillip A. Walen (S), John R. Wiesenfeld

TORREST TRANSPORTER

Student Status

John Baker (Al, Wayne A. Basden (S), Tom A. Brikowski (VI, Darcy Gampbell (H), Tianqing Gao (S), David Ghason (Hl, Yong-ohun Chen (T), Sieve Chipera (V), Matthew Gordery.

Philip H. De Groot (HI, Ron Elan (V), Lydia K. Fox (V), Mark Fries (H), David W. Glos er (S), Scott Hammond (A), Vicki Hansen (V), Siamak Hassanzadeh (S), Larry D. Hinz man (H), Ghing-Hui Hsu (O).
Erik Jackson (S), Robert B. Jacobsoo (H),

Joshua L. Jenkino (H), Bradley L. Jolliff (V), Fellcia J. Kegel (T), Kelly L. Kenison (O), Eirik J. Kennster

Jung Mo Lee (Tl. David A. Lisie (S), Fauls
Jung Mo Lee (Tl. David A. Lisie (S), Fauls Luboroky (H), Galunt MacDonald (S), Ian.
Madin (T), Stephen R. Mateskon (T), Cacilo McGloy (O), Richard McKinney (O), Debta Meese (A), James F. Milne (S), Martin Lane . Mitchell (O).

Garlos E. Nimez (S), Jeffrey L. Peterion Mitchell (O).

(H), Bernard Pisarchick (T), William M. Port ers (S), Garol J. Placek (H), Howard W. ets (S), Garol J. Ptacek (H), Howard W.
Reeves (H), Jeffrey Ridgway (GP), Stephen
Ridley (T), Scott D. Sachs (T), Frederick StaRidley (T), Scott D. Sachs (V), Robert Silest
tena (H), Thomas Stanton (V), Robert Silest
tena (H), Arnon Sugar (T), Stephen T. Sulton (I)
Margaret A. Thomas (V), Lisa Toothaker
Margaret A. Thomas (V), Lisa Toothaker
(H), Vaneosa Weslow (S), S. I. Whitlow (O),
Mark Thomas Wildley (T), C. B. Wolbert (H). Mark Thomas Winter (T), G. B. Wolbert (H)

Robert Yonover (V).

54.

of the velocity profile. This enables a preterrad solution to be constructed for each section of the velocity profile. The preferred velocity-dapth curve for a region of a gnels-moneoutle rock body at depths between 25 and 234 m shows minion that correlate with the positions of sajer fractures on high concentrations of tractures on high concentrations of tractures in Terred from optical seemination of ore amples, laboratory measurement of velocities, and tube wave stadies.

GEOFRYGICS, VOL. 15, ED. 7

Geochemistry

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of 0.1 - 0.1m iron the ground surlace. The mese
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Geodesy and Gravity

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Themosymeric Christian Remisphere And Compositional
Structure of THE Scuthesh McMisphere Buring OctoberHowever by The Scuthesh McMisphere Buring OctoberHowever 1981
R. G. Robis (Mational Center for Almospheric Relearch ,
Bouldar, Colorado 80307), R. A. Enery, R. E. Oickinson,
E. C. Ridley, I. L. Killeen, P. S. Mays, B. R. Carignan
and R. V. Spencer
Themospheric Composition and winds at
F-region heights ever the Southern Kemisphere polar cap
have been measured by the Dynamics Explorer (BE-2)
satalitie during October-Rovember 1981. Perigee of the
GE-2 satalitie during this period was over the Sauthern
Hentsphere polar eap, and measurements made along
0900-2100 docal time polar pates are used to determine
the everge Universal Time dependence of thereapheric
properties for this local time slites. The F-region wind
vector is derived from the meridional wind component
measured by the Fabry-Peret Interferometer (FPI) and the
zonal wind component measured by the wind end Lemperature apprehenser (WATS) instruments on board BE-2.
The neutral gas temperature la derived from FPI and WATS
maturaments, and the compositional structure is determined from the neutral almosphere composition repairacate (MGS) instrument. The measured temperature,
corposition and winds along the G000-2100 local time
polar passes all diaphay e Bulevensi Time dependence
Units due is the displacement between geomegnetir and
geographic polars. The lemparature and molecular mitrogen
dentities are ananaced and the simmic oxygen density is
reduced to the magnatic polar cap compared to loverhalludar vergions. The neutral wind pattern foilows the
pattern of ion driff ossociated with magnatospheric
convection.

The ACAR thermospheric general circulation model pettern of ion drift ossociated with magnatospheric convector.

The ACAR thermospheric general circulation model [1804] is seed to calculate that temperature, compastion and winds over the Southern Heelsphere palar cry region for renditions similar to October 1981. The total for renditions similar to October 1981. The total includes teparated geographic and geocagnetis poles. The temperature, composition and winds one determined along the DE-2 satellite track for various Universal times. The calculated winds are in general agreement with two charved winds, with both having a two-teil palarn of megnetospherir convection. The calculated and observed composition pattern are also in general agreement with encoded when models and observations ore normalized to the Functional pattern of the calculated and charved calculation and observations ore normalized to the Functional pattern of the calculated demonstrate palar rap accurate near 0300 UT, when the dawn soctor of the sureral oval passes ever the south geographic palar. The overall pattern of the calculated temperature variation is smiller as that observed except for the particular of sureral patticle praclipitation within the influsion of sureral particle praclipitation within the influsion of sureral particle praclipitation within the ingles of the particle praclipitation within the magnetospheric cusp.

J. Secopose. Ros., A. Papar AAC759 J. Geophys. Rau., B, Paper 480740

O720 Electromagnetica
FATE INSTANILITIES IN MINOTION DRAWS
FATE INSTANILITIES IN MINOTION DRAWS
FAVMILIED THROUGH MEDIA WITH A RANDOM
DIMLECTRIC CONSTANT OVER A ROUGH SURFAGE
7.6, Mass, A.A.DRIJGENOV, G. MARTITUTA,
d.I. Randoms, and Y.M. Kakevenko (Instituta
af Radiophysion and Electronics, Academy
ef Sciences of the Urrainian SSE.
Markov, JIO005, USAR)
A new type of the beam instability is
analyzed which results from energy suchange
bawsso the fast and slow waven in a beam of
charged portioles. The intersection is
sonditioned by a random non-uniformity of
atther the medium er the surface. The power
hossmary for wave amplification is provided
by a 4.0. Electric field source. (Instability,
Essivon beam, random media).

Ind. Sti., Paper 450746

J. Geoghya. Rom., A, Papar 4AQ759

Electromagnetics

Geodesy and Gravity

1910 Righ-order harmonics of the gravity potential field and local gravity anomalies GRARITY EMPHHICAL COVARIANCE FALUES FOR THE CONTINENTAL UNITED STATES Clyde C. Goad (Majienal Geodetic Survey, Charting and Geodetic Sarvices, Rational Oceanic and Atmosphanic Administration, Rorlville, Maryland, 20832], C. Christian Tscherning (Danish Geodetic Institute, Charlottanlund, Domaark), M. Miranda Chin (National Geodetic Survey, Charting and Geodetic Sarvices, National Oceanic Sarvice, National Oceanic and Atmospharic Administration, Rockville, Maryland, 20832]

Rariances and correlation dislances have been detarmined for terrain carrected Bauguor anomalies in all 30° x 30° black covaring the continental United States. Also linear Irend values were subtracted from the data.

In order to make the detarmination independent of the frequently Irragular lard data distribution, gravity values pradicted in a requier grid were used. The production was made using learl-squares collection, constructing local surfates representing the gravity anomalier for each 30° x 30° blook. Far this purpors 344000 terrain corrected Bouguer anomalies were available in the U.S. National Geodetic Survey gravity data bass. Therefore, in order to limit the computational effort, a acquence of surfates were determined by salecting in each block an increasing number of data points until a limit of the absolute value of the error equal to tingal wes reached. This procedure reduced the number of gravity observations used per bloch ta a very few (in cross of filling gravity variation) to day anomalies to a secretar with the gid-cantinents gravity high and tationic feeturet an the Pacific cast.

J. Coophre. Rau., B. Paper abolico

Geomagnetism and Paleomagnetism

2500 Time varietions, Palacquegnating PALEOMAGETIC AMP OROLOGIC DATA 1801CATING 250P (M OF APETHAMED 015PLACEMENT 708 THE SALIETAE AEG RELATIO THERAES, CALIFORAE Tranges, Catifosate
D.T. Champlon (8.6. Goological Morvey, 345 Middlefield
Red, Menio Tark, Ca,94025),P.O. Howelf and C.S. Gromma
Feculta of a pair of peleosagoefic etudies of aedisentary rooks in the Saitoles tarrass of vesfarancet
Californie indicara a morthward displacement of sboot
2,5PP km alone Cratacomus Fice. Stratigraphic rale-2,5PP km alone Cratecous flor. Stratigraphic relations suggest that the Satinian farrance became each general with several others by the inte Gratecous at all underwest the same northwers tressistion. This composite terrans is indepthoni become sutured for cratecous Morfh America by early Terfiny time. One paleocognetic study insolved Upper Cratecous turbidities of the Pigoco Foint Fm. Fine-grained, thin-bodd hyphidizes yielded the cost reliable results. Whereas

resultant for wars amplification is provided by a 6.0. Electric field source. (Instability, lapiron beam, randem media).

Ind. Sti., Paper 450746

Exploration Geophysics

Exploration Geophysics

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THE DOLG OF SIGNE CONQUISE MODELE IN HYPERESETATIONS OF THE DOLG OF SIGNED CONQUISE MODELE IN HYPERESETATIONS OF THE COLG OF SIGNED CONQUISE MODELE IN HYPERESETATIONS OF THE COLG OF SIGNED CONQUISE MODELE IN HYPERESETATIONS OF THE COLG OF SIGNED CONQUISE MODELE IN HYPERESETATIONS OF THE VALUE OF SIGNED CONQUISE MODELE IN HYPERESETATIONS OF THE VALUE OF SIGNED CONQUISE MODELE IN HYPERESETATIONS OF THE VALUE OF SIGNED CONCURS. THE PROPERTY OF THE VALUE OF SIGNED CONQUISE MODELE IN HYPERESETATIONS OF THE VALUE OF SIGNED CONCURS OF THE VALU

by the model studies are, indeed, observable to survey data.

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Hydrology

groundwafer toservoic ess modified to incorposate effects of a thin leyer of low-permentitly marerial oc iracture akin that may be peason at fixefus-block interfaces as a result of sinesal deposition or alrestion. The commonly used finesy for flow in double-porceity iormations that the based upon the assamption of pasudo-stoady satisfy for flow in double-porceity iormations that the based upon the assamption of frantone, block-to-fissure flow is shown to be aportal case of the theory greated in this papes. The latter is based on the assamption of frantone, block-to-fissure flow utth fracture skin. Sinder conditivity first to loss than that of matrix rock if say be assamed to impode the laterchange of fluid between the fissures and blocks. Besitzed to flow at fracture-block interfaces tunds to reduce apatial variation of hydraulio-head greditors within the blocks. This provides rhoorefired justilisation for neglecting the divergence of flow in the blocks carrently by the pasudo-atasety state flow node. Coupled bouckery value problems for flow to a validischarging at a constant rate were onlyed in the Leplace domain. Both elab-shaped and aphase-shaped blocks were considered, as were affects of vali-bore across and vali-bore skin. Essette, obseined by numerial inversion, wear used to construct dissonation—isse type curves that were applied to walt-test date, for a pusped well end observation walt, from the iractured, voiceal-crock terms of the Marada Teef Ste. (Wall bydrauliss, fractured rock, Laptace trassioten). JIIO Hydrology | Erealon and Sadlmentation; | A PROSABILISTIC APPROSCH TO THE SPATIAL ASSESSMENT OF SIVER-CHARMEL INSTABLISTIC WM L. Oraf | Department of Occupanty, Arisona Osale university, Temps, Arisona, U5287; | The determinable approach to the analysis of river-channel instability has not proceed to be a completally useful basis | For geographic productions of ahannel behavior. Economic astimates for behavior and the region of the same | Department of the analysis of the same | Department | Department

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fARMINIA tobarrication of Groundwayes applies models,
a Grieralized teast squases approaca
J. Sadophipour litti Englumering Department, Univereity of Teilfornia, tos Angoles, EsilTornia, 900241,
y. N-G. Yeh

alty of Telifornie, too Angoles, Telifornie, 90024], V. W-G. Yeh.

The paper concerns the methods of celimating aquifor transalsutylius on the hasis of unstandy strict productions of the second of the celterion of ministring the sup of the squares of errors has been used to makel the observed dark with the model response. The date used for optimization usually contain noise which is not necessarily uncorrelated. It is welt understood that the results of identification methods are very sensitive to measurement errors in dars. In this study, the offinery least Squares (615) rechnique is carried out clong with a Generalized Least Squares (GIS) technique is carried out clong with a Generalized Least Squares (GIS) technique to the sense of the coverience tetrix is used as a bessure of overall acturacy and reliability of the celimated parameters. The effectiveness of the OtS and CIS techniques in design with noisy duta is denonairated by using a hypothetical campiu. The results of numerical experiments suggest that oth old of the celimated approach in efficiently ipproving the reliability of the saticated parameters.

3130 Groundwater
DOUBLE-POROSITY MODELS FOS A FISRUARO GROUNDHAYER
RESERVOIS WITH TRACTURE SKIN
S.F. Moench 10.3. Geological Survey, Menio Park, CA,

ti60 Ounoff and Streamtlow
ON THE TREATMENT OF EVAPOTRANSPIRATION, SOIL-MOISTURE
ACCOUNTING AND AQUIFER RECHARGE IN MONTHLE MATER
BALANCE MODELS
Milliam M. Alley, (U.O. Geolegical Survey, Retton,
Virginia, 22092)
Several two-ta-six gecametas regional wotar balance
models are assained using 50-year records of romibly
streamflow at 10 sites in Now Jersey. Those models
include variants of the Taconshwalte-Mather redal, the
Paleer model, and the mode arecent Thomas about redel.
Calibration and prediction errors are rolstively
similar among the models. However, simulated values
of stale variables such as soil-moisture starage
differ austianially among his models, and fitted
parameter values for different models sometime:
indicated an emilrely difficient type of basin response
to precipitation. Some problems in paremoter identification are mated including difficulties in identifying
an appropriate time-leg factor for the thornthwalleMather-lype model for bosins with little groundwarer
alorage, very high cearelations boswen upper and lower
ctorages in the Palmon-type model, and lacys cansilivity of parameter ef the about oncol to biss in
astimates of precipitation and potential ovepotranspiration. Medifications to the throshold towaret to
ha Thornthwallar-Mather model ware stallsificatly valid
far the 6 stations in northace New Jorsey. The abod
model resulted in a simulated seasonal cyrle of greandwater lavels similar to flutuations observed in noarby
walls but with greater persistency. These results
suggert that astreme caution shauld be used in thisching physical significance to rodel parameters and in
using the state variables of the rodels in indicor of
drought and beath productivity. | Meler belance

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1160 Punoff and Streamflow ATTERATION OF STREAMFIOW MERRA FRESTING FOLLOWING POAR-CONSTRUCTION IN SORTH-CTNTRAL IDARIO 1. .. Fing 1950s intorcountain Forest and Pinge Equilibria Stellos, 3-221 5. Salo, Noscoa, 10 April of L. C. Tennyson.

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variables were monitored on six formated headwater wareacheds in motth control idaho. The attrambles variables were: annual chaires streamlion, date of trainum streamlion, annual ristour attraction, source water yield, and streamlion squaled or exceeded \$2 ml the year, \$25 of the year. The watersheds, reaging in oran Iron 26.6 to 144,0 ha, had tens then \$2 of Refr uses in reads. Two statisfically stpsificant [= 5,65] changes occurred foliosing read readstration: as terresum in the \$2 of reaccions lines in one watershed and a serresum in the \$2 oxeredance flows in material autorabed. The significant ringes were detected in other flow pararatures on any of rhe watersheds. The results indirate that the hydrologic behavior of small forcorred watersheds may be sitered when ruly a scale area in diarribed by roads. (streamlion, scade).

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3474 Soll Moleture TRAVEL VINES VEGE SURIED AND SUBVACE INPLUTEAVIOR POINT FOURCES
J. R. Philip ((StRO Otvialon of Environmental Mechanica,

A. R. Philip (GRRO Otvlaton of Environmental Machanica, J. R. Philip (GRRO) to lateralia)
Solutions in closed tore are found for the inswet times of marked particles from beried ond sorface infittretion point sources. The study is based on the quasilinear analysis of steady thron-dismesional graphicality on attracted flow. The results are presented glaphically onesturated flow. The results are presented glaphically convection-diffusion processes from continuous point sources at the appropriate infinite and seat-infinite regions. In the soil-water context a limitation is that travel veforties are based on on mean volumetric molecular context. (Yrawof clear, infiltration, soilure contoct. (Yrawof clear, infiltration, soilure cracaport, convertion-diffusion processes). Veter Resour. Me., Papas 440626

2175 Cott Maistere ALCEBRAIC EQUATIONS SON SCHUTZ MOVEMENT DURING

NOCORPTION 2. Catson lechoof of Civil Engineering, The University of New South Cales, Keneington, M.S.C., Australial 864

e. J. Jones.

Perentry published enalytical sotetions for nonreactive solute nowment in unsiterated porous esterists are ive solute nowment in unsiterated porous esterists are try level with the aim of developing slepts algebraic equations which can be used with conflicted or fredicting solute disposition during abnorphion. Quasi-analytical solutions for constone composition, quasi-analytical solutions for solutions using a velocity independent hydrodynamic dispositions using a velocity independent hydrodynamic disposition. The solutions for standard to a simple yet accurate fore. The solutions for standard to a simple yet accurate fore. The solutions for standard the first the content of the restrict of the properties of the companies of the particular diffusion and seckanical disposition have companied algorithmatic and the maintain of the companies of the companies of the solution of the standard of the solution of the solution of the solution of the solution of the standard of the solution of the s e. J. Jones.

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YECHELQUEE FOR MAKING YIBITS ELEMENTS COMPRIYIVE IN MOOFTING FLOW IS VARIABLY SCITUATES PORCON REDIA P. B. Rejators (Geoffens, Inc., Reaton, Vitalis 22090). A. P. Thomsen and S. W. Thompson.

A Calertic Hights olsment formulation of developed for the numerical stamulation of water lies in variably-naturated soil agetes. Included in this formulation is a solution strategy based an Precard and Newton-Raphson aggorithms. Both signilians are deatgred aspecially to cope with severely positioner field prohiess. Yhe two significance as usuafaced for field prohiess. Yhe two significance is usuafaced for field prohiess where the separate of the making a technique referred to as the "inflance cauner using a technique referred to as the "inflance cauner using a technique referred to as the "inflance cauner using a technique referred to as the "inflance of the inflance of the field of the field to deconstruct the affactioners of the present limits element approach. These examples about that the nonfigurer solution achoese are capables of accommodating rams involving longs variations to the survated hydraulic conductivity, as welf as highly nonlinear solt on lature chemacter. Inflance is a highly nonlinear solt on atture the accommodation for the Picard and the Shewton-Laphson algorithm to a too provided. The acody sedicates that despite the higher test per treation of the Newton-Laphson algorithm to a the Vacard per treation for the Newton-Eaphson scheme. It usually tequires a substancially smaller content of the Picard scheme, it is delicated that despite the higher test per treations the Children that despite the higher too test per treation in the Newton-Eaphson scheme. It was the Newton-Eaphson scheme in order to was the Newton-Eaphson scheme in order to death a scheme in the Newton-Eaphson scheme in order to death a scheme in the Newton-Eaphson scheme in order to death a scheme in orde

TIAN Gater Quality
EMERIAN-LAGANGTAN SOLUTION OF THE CONVECTIONOISPERSION EMATICAL OR NATURAL COCOCIONTS
O.T. Chem Sater Percures Division, USG, hemic Park,
Criticatia, 040216, V. Cesaili and R.S. silfood
The was sejoricy of measured lovestigations of
transport phenomena use an Enjerico formulation for the
conventence that the compatational yields are fixed in
space. An Emissional system without film of solution
for the convection-dispetation equation is liacused and
solution in the EM over the Legrangton concept in an
inferion comparational grid-system. The values of the
depolate variable oil the grid are calculated by
interpolation. When a flower interpolation is used,
the sethed is a satisfic improvement near the up-wind
difference eathed. As this level of approximation both
the EIM and the up-wind difference sethed suffer from
Lagrangton polymentals are used in the interpolation,
the EIM is proven to be face of conscient desperation
for the convection-dispersion equation. The concept of
the EIM is actuated for treatment of anisatropic
dispersion in natural conditation. In this approach,
the EIM is actuated for treatment of anisatropic
dispersion in natural conditation. In this approach,
the substantials the results of dispersion can be
conveniently related to the proparties of the flow
field, Soveral meanical examples are given to luther
substantiate the results of the present analysis.
(Pulmetan-Lagrangtan, convection, dispetation,
esteries).

3f99 [General Hydrology F A STOCHASTIG OFTIMIZATION MODEL YOU REAL-FIME OPERAFION OF REPROVING MAINTENANCES Sinhin Potta [Saler Assaurces Honogarest teberatory, Depontment of Agriculture Sentineting, tot Agricul-tural Fontage and Dallding, University of Agricul-tural Fontage in Building, University of Agranus Deportment of Agricultury Socianceling, Our agricultural Engineering Building, University of Arkaness (1901) and Sark II. Hauch: A resisted operation of reservoirs in developed. This middle is beaud on a chance constraint formatation and atmater a gannituder fore of the finest Decision businesses at gannitude fore of the finest Decision businesses. These Cols are constraint formatation and atmater a gannitude fore of the finest Decision businesses. These Cols are constrainted in informatical statistical properties of howevers errors for afforced in the Schotland for the statistical properties of howevers errors for different time steps. The objective tenture are sufficient time steps. The objective tenture and the probable deviations from storage and rature to so intrinse and the relimbitity tavets reperfiled in the model. Oth the use of target values for a nelesse and atmospherical the second of a return operation. As sufficient operation according to a control operation. Also as a subsett of a seasonat golder and everywhere the supple (whatt-sighted) nature of operation. Also as the properties of the applicable of the support the first operation as a subsett of a seasonat golder development is best builting and officienty of this applicable. This model is a subsettion of actual operation associated with the use of the support of the properties of the support. This model is a subsettion as a subset of the support. This model is a subsettion of the support. This model is a subsettion of the support. This model is a subsettion of the support to be applied to be a shown to be takened for the model. Support the subset of the support of the subset of the sub

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LICK BISTRABUTIONS" OT J. H. LARKATHE, E.C. MATALAS, AND
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J.W. Dandshu hCEFFE, Cacsun da Ferquiaes de Energia dié
crica, Ctéada Univerataria, Ilha de Fenden, Calsa Fezret 29fA, 21.910 - 210. de Janchen, 21. - Ersail)
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tog-normal distributions, assed the Cumbal assithe
tog-normal distributions, assed the Cumbal assithe
ho show that this patentialty dangrood situation dens

not accessarily extend to all of the simple common distribution. In practice it is considered the two paterester exproaction distribution. Water Remour, tes., Paper 440322

Nator Remour.

1899 Contrat

Rey HARTION OF SYEMELIE S P HyproLouic Yaslants

V, Yavjavich inchool of Engineering and Applied

Relence, Cooreg Washington Chiversity, Weshington,

S. t. 200521, J. Y. S. Obsyshers

Various mathods of estimation of skewmans conditions
to Plus, verious, seen aqueta error and robustness.

The underlying population distributions are limited to

Messax (Poerson Nyo 111) and logorand. The straintion
resulce show that a new showness esciment which messar

the subsample verience between the subsample man and
the subsample verience between the subsample man and
the subsample verience heat leaser hims than the oldimary showness estimators. It may be used as a surrogera
when the sample size is sould and population skewmess
large. The superior estimates of skewmess resulting
iros the maximum likelihood sucleanism of preservant of
the known underlying distribution and the robustness
studies point to the importance of the correct inference on the type of underlying probability distribution
function in hydrologic applications. (Skewmess,
estimation, tobestness)

Wetar Rescer. Ngs., Paper 480343

Meteorology

NOS ALT QUALITY (ORDINA Measurements)
HEASUREMENTS OF FEEZ TROPOSPERRIC GEORE: AN AIRCRAFT
BRANKE FROM 4% NORTH TO 46% SOUTH LATTUNG
G. L. Grogory Hakinonal Accommuted and Space
Administration, Langley beasured Canter, Heapton,
Virginis, 236551, S. M. Beck and J. A. William
Ordina deba ware obtained in the free troposphere an
delicuries of 5 to 7.5 hs and at latitudes from 44% N
to 46% 3 Guring a 3-week period from Ordober 19 to
November 4, 1982. Plight trajectories included the
continental 6.8. Contral Resitor, and the western
omain of South Awarieu. Harlams observed orgon was
tid pob at about 44% B isfluxde and at sm attitude of
7.3 hm [MSL]. Analysis of the deta as a function of
latitude showed a rogion of olevated oxone in the
southern latitudes strending from about 2 to 30% in
which latitudies oxone averages (2% bends) posked at
about 86 ppb. Geome concentrations, measured at
northern latitudes wore lower, everaging about 35 ppb.
A discussion of the daha, including comparison with
other Geord data mets, is presented,
J. Ceophys. Res., 0, Fapar 400712 J. Cropbys. Res., O, Paper 4D0712

J. Crophys. Res., 0, Yapar 400/12

3115 Watsoralogy (Chemical Composition)
A biASAYIC CIPCILAYION EXPERIMENT IN A TWO-PIHENSIONAL PHOTOCUBRICAM MORE.

7. O. Cuthric (MASA/Doddard Space Yiight Conter, Code Q&A, Craombalt, ND 26771), C. B. Jackpau, J. S. Roruse, and C. J. McQuillas
A two-dismandsmai photocohomical model based on the disbatic circutation box been used to atmints the behavior of N.O. CPCL, [P-11] and C.C., C. (P-12). The circulation is based on extinate SP out bearing from the ground to 60 km. Eddy diffusion has base reduced with resport to other model studies with \$ _2810^2 cm² warybers showe 199 mbsr. Resulting \$70cm pro-ities show reasonable agreement with measured profilm in the tropics, and isli off such more sharply with sitilude 19sh those produced by models using largur values of X. The ugrassout obtained is at least ea good as that obtained with edjustable addy-diffusion parareters. The dishatic circulation treatment is more risouly relaxed re real physical processes, and the more risouly relaxed re real physical processes, and the more resulty interpreted. Sitfusive mixing appares to be more important in determining the decisie of the tracer distributions rather than the basic corphelogy. (Fracer transport, source gases).

J. Deophys. Lus., S. Paper CD0115

MAYNE.

SOME PROTORS AFFECTING THE REACTE SENSING OF SEIN OF POLABILISTICS OFFICERY PADAP IN THE 3-25 GMA

FOLGARIENTICS OTTUBETTY PARKE IN THE PTY ONE
PROCESSEY PARKE.

N.O. Bolt Hathenstics Department, University of Essex,
Colchaster, COJ SQ, U.K.;
The use of polarisation diversity reduce, both CDS
and EDP, for the remote sensing of rain is investigated.
In particular the depandence of the peasurements on
Frequency, and on the model adjumptions shout the rain,
Invoh as shape, dropates distribution, Lamparators and
canfing angled by discussed, at O-bead frequencies,
propagation effects are shown to be worse for COS than
for SDR talars. Foldarisation diversity Refar, rain,
recote semaling.

Mineralogy, Petrology, and Crystal Chemistry

CARLA CALYSICAL CHRISTINGS.

C260 Paragenesis, petrography, and patrogenests

Sr-MOTOPIT VARIATIONS ALONG THE JUMB ON FUCA RIDGE

Jacquatine Eaby (O. S. Geological Survey, Net-SEQ, 2Cl

siddefisid Md., Kente Park, CS, 90028], David A.

Claque, John E. Ontaney

RT-isotupis rathes of 19 qfass and microstystetline

besalt samples along the Juan de rêce Ridge sad t giose

sample from Brown east Fasconnt are at the tower and of

the rangs for normat wid-cousets ridge besalt; the

average "Vgr/86%" ratio is 0.1010000,00010 [12-signal.

Although subths variations saint along strike of the

ridge, the Er-isotope dais do not show systematic warl
ation rathetise to the proposed Cobb Sotspot. The iso
topic data are inconsistant with an sariobad santis
plane setigin for the Cobb-Eichalmer Seasons chain, as

has been proposed for ineland, the Amorea, sad the Oni
spages systeming center. dr-isotopic ratios of samples

ontheoide notto and south of the Cobb Offset as a iden
tical, sithough minor element ratio indicate that

these magions have obsciently distinct mante sources.

These distinct mantle sources say not have hem separ
ated long enough to develog isatopic differences.

(testope geochesistry, MORS, santis betarogenatty,

botspotl.

J. Geophys. Res., S., Faper CSELON

Oceanography

4fio themicst Brasmography OCEAN LIES CYCLES AND THE ATMOSPHERIC COF CONTENT T.-H. FRAM [Environmental Sciences Obviolog, Dak Ridge Satiogal Laboratory, Oak Ridge, Tennessee 3f831) and W. B. Srocker

W. B. Frocker
Organic rarboe to the ses was considered Py sone
biologinic as a stat for so-called "signing-carboe."
But there is o reason to bettere thet sathtropognic
impate hers significantly situred the net prodestize
rate of organic residues. The possibility that changes
to the ocean's sadisleid ratios, in the ocean's plact
prodestivity, of in the extent to which organic smerial
to recycled within the ocean kews significantly alised
the stronghera's CO; cantset over the past nestury to
sameled. Modets show that the organization of the
situanthous in them processes necessary to prodess
significant CO; thouges are unreasonably isrgs. An
absermational approach (i.e., repeated surveys of the
distitutions of O; Mo, and FO, to the seal sileue
the propored biological occurried web to 1972 [Organics)
and in 1981 (TTO] reveal so significant trend for the
thousaction of the Kerih Attoric over this nice year
period, a longer period of observation with in successary
below itre liwits ran he placed Urrough this observations
approach. (Carbon, sortropognatic typesta, thereocline
sortients, modets of biological scenarios!

J. Geophys. Esse., C. faper 400f11

4711 Ctraulation (Sutf of Mexico) CHURRY AND HYDROGRAPHIC YARIABILITY IN THE VESTERN GULL OF MENICO

Bavid A. Brooks (Department of Oceanography, These A&M University, College Station, IX 77843)
From July, 1980 to february, 1981 10 current meters on 3 meetings were deployed in the 200-700m depth. Tabge over the continuated slope in the northwestern Outle of Munical The current were characterized by energetic fleatabilions with these scies of 8 west to maverel months. Newworld-drifting thop Current agtic, case provided the principal driving sechnation for the floctuations. In openiors current speeds at the 200m depth occasionally exceeded 70 cdys and wirelegate the continually exceeded 70 cdys and wirelegate the continual percentage.



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only marginally coupled with the einde cassured et Brommaville, Ta. Tidel molions occounted for is of the cerrent verience. (Loop Current onlicytiones, turnant meaturements).

Piun -

A Geophya. Eas. C, Paper scores

4765 Surtuca waves, 11dna, and tag iseal
THE EST MAN10N 9F 'GLOBAL' SEA LEVEL CHANGE: A PROBLEM
9F UniqueNESS
T. P. Bermati (Strippe intiituia of Geomography, A-62A,
University of California, San 9iego, La Jolia, Coliforaia 9293).

An objecties method of estimating ragional everages
of coherent as ioval (SL) chengs is developed. The
sechnique is applied in a large set of SL data reprasentative of most of the werld's continental margine.
The recutit show highly coherent SL thanget over many of
the regions studied. The method is then applied to the
regions toutled. The method is then applied to the
regions deverage lhamacives to develop an overait estime to fihe toherant patient of SL variations exlating in the historical SL data set. The patters is
coherent tried by a coherent rise of SL in all regions
except Alatha, Standinavio (both areas of maleriaua
counts apifft), and Sonaheast Asia where SL appears
to be felling. The meniyais suggests ittis or no
thange in SL prior to the serly 1900's. The period
sinto that like has seen an increase in SL that is
aptimally fit by a linear trend of 23 cm/hent.

The study results auggesh that it is not change of
SL or even the averago rate of change associated with
the existing (inadequata) data set. Indeed, difforent
existing (inadequata) data set. Indeed, difforent
existing the stimules of SL trend is the existing data
cai.

A signal/noise enelysia suggests it should be easy to

tiont is the attimates or at trans to the control of the control o

A799 Constal [Oulf Screen Sings]
MASS TRANSPER DETWESH GULP SYREAM SINCE
Pichard F. Wiled and Gloria J. Lindersons, Marine
Yecknology Plyision, Navel Semestroh Labotscory,
SaperLowest are parformed to memeios the close
interaction of two satisfications of the close
interaction of two satisfications are resulting.
A tracer is put in one ting initiality, is severing,
and diffuses into the other as the pair evolve in
time. The appearance of the tracer strenhlines is
examined in the light of conservation of pornation
overteity. Finesperic viscosity and tracer diffusivi
are each varied over two orders of magnitude, and
tracer Pahavior changes grouily. The selogy of
this work to the tutaraction of a warm tore ring
with the Cotf Stream is made, with the attrammera
observed in the work corresponding to these
J. Osophys. Res., C, Paper CCO3Y6

Particles and Fields— Interplanetary Space

5370 Soier wind magnetic fields
RADIAL VARIATIONS OF LANCE-SCALE MACHSTORYPRODONNIC
PULCTURIONS IN THE SOLAR WIND
t. P. Buriage (MAGA/Goderd Space Plight Cester, Lab.
for Extraterementrial Physicae, Code 692, Greenboit, MD
20771), and M. L. Golostelle
Two Lime periods are studied for which comprehensive
dahs coverage is avoitable of both 1 AU using IMP-6 and
1938-3 sed beyond using Yoyeger I. One of those periodu
is characterised by the prodominance of Cortentiny
etrems interestions, whereas many translent flows were
observed in the second period. The coulation of flows
two flow systems with belicoentrio distance is obtained
two flow systems with belicoentrio distance is obtained
two flow systems with belicoentrio distance is obtained
two consoling samy translends to consistent with the
hypothesis of turbulent evolution, lociading on invarue
coscode of amperio belief by to large sonies. The
swoighton of the corobating period is in agreement with
the expectations of a determination offsit in particular
ic is consistent with the "estroiment" of allow etronom
by fasher etroions.

J. Campye. Res. A. Paper CAD689 J. CsapPys. Res., A. Paper CAD689

Particles and Fields— Ionosphere

3305 Airgiow
**BIGGY AIRGON ON (6-3) BAND ROTAYIONAL TEMPERATURES
AT POKES FLAY, ALASKA
***L. S. Nyroby, 'Gorwegten Deisone Sesserth SatuPitakoner, R-2007, Kjelter, dorwnyl, C. J. Semich,
G. C. Styjes and C. S. Deskr
Temperatures of the smeapages region (51-90 km) have
been dedocal from 05 (8-3) so tsoular beed night airglow
sateston measurements made at Foter Fizz (63 M), Alashe.
The data rator the first foor mouths of assh of the
years 1976, 1977 and 1875. Heap capathy temperatures
of 213, 224, 813 and 193 Serie obtained with so significent yearly differences. The mean temperature for
such sock is about 518 higher then the representative
sonthly temperatures in the 68 and 90 km, 60° and f0°M,
CIRA 1972 model, and the follows the general decreasing
trand shown by the model: (03 Airgiow, temperature
meanspause, high lacitude).
J. Ocophys. Res., A. Paper 4A0766

SS30 Stgb-Latirade tocompheric Currents
LORDSTRIC CND SIENTLAND CHORST OLSTRIBUTION FOR
MORTHMAND INTESSLANDTARY MAGRITIC YELLOR INTERED
POLAR CONVECTION

t. J. Zametti, Y. A. Polanza, P. F. Bythrow [sil at
Applied Physics LaPoratory, Johns Sopkins Batwarsity,
Lauri, Maryland 20707), T. Itjies, [Delegraty of
Tokyo, Tekyo, Japen), Y. Samijchoo, (Hax-Plauch
Youtlitat For Sairg-Larrastrisi Physics, Magich, West
Sarmagy)

range, raye, Japan, U. Samjehon, (Hux-Plauch Ynstitate for Safre-Intrastrial Physics, Ruelch, Vast Sarmany)

I new, stable systre of Sirksised and Loncopheric corrunts has been added to the exteting Saglon i Saglos I surverst classrajat system when the interplantative magnetic flatd (187) to dirented corthmerd. These corrushe wrist potenced of the Saglos i system, sarets the poter region and heve heave cotsel the northward USF S. (230) Current system. A compation paper (ttimm at al., 1984) 'disarrhas it dehalt the Strasfeed sermonds' magnetic algorithms to any particle. In the summand-satisface of disarrhas its strasfeed sermonds' magnetic algorithms. In the SEE system's dependence of the vertons components of the USF. The compation study send MADSAT magnetometer the INF. The compation study send MADSAT magnetometer than iron the only. System's particle of the USF. The strategy of System's dependence of the vertons components to the USF. The strategy of System's statistic of the Strategy System's statistic in tegeral to the USF. The strategy of System's statistic in the same and lysts of the Interthenth (computer stratist is the said flaid to detive the impossibility detreat pressure

during the above two days. The MSI facospharia current system has about a similar "" pattern with antisonment current (leptying summand convection) evar the magnatic pole with return currents on sither side. Multi-rell patterns canapairen the MMA locospharic patterns and an asymmetry appears to be reserved by the tMM e. component as well. Suggestion are given for multi-rell patterns over the polar regions for northward UMP during an IMM & sign change.

J. Osophya. Sas., A. Paper 4A0753

5515 Interections between waves and perticles PERTURBATIONS IN THE VELOCITY DISTRIBUTIONS DI A COLLISCOLISIO PLASMA J. W. Dungay islanchetr laboratory, Especial College, London SN7)

London SW7)
Linear theory is presented in the rea-dimensional
geometry with ongoeds field lines straight and persist
and att gradients perpenditular to them. With the
caperturbed state errorified, the periodicity of any
perrical trajectory leads to a simple condition
sencerning the energy exchange between resenant persists.

perficie trajectory tunes to a simple conductor sentential transcript the energy exchange heaven resonant perfeits and a vere.

A Largor radius expansion is performed locinding the second hermonic of the trajectory fraquency, but as higher betweenies, and inclading the gradiest of the significant field, which would be ensential for Edwin-Belwheitz iontability. The objective is to desermine the dependence of the percurbations on gyrephase. The important result is that the third Fourier component is of second order to the Largor radius. The expansion is varied, fice structure arises only from resonances. A less rigorous discussion of the opposite case, treating the magnotive field as weak, shows the particles faster than the phase apead pass through resonance in the sames of sentionary phase. This generally dominates the perturbations and generally these very rapidly with gyrophase. [Saves, velocity distributions.]

J. Osophys. hea., A, Paper 4ASDCO

5540 ion Densities and Tomporaturen
O+ ion Acceleration Due to PESISYLYE MOMESTER YEAVER
IS THE AUBORAL PLEAD LIE PLEADE.
N.G. Hitchell, Jr. (Vissue Physics Division, Mayel
Research Laboratory, Washington, O.C. 2017) and P.J.

N.G. Hitchell, Jr. (Vissos Physics Sivisto, Arest Rasearch Leboratory, Waskington, O.C. 2017) and P.J. Pateadons
Low frequency sloctric fleids maintained in a plans by resistivity jeither collisional or wave-inductivity a balance between the momentum transferred to the slectron by the electric fleids and that transferred by the restativity from the electron to the sparience a not acceleration due to the electric fleid. It the planes contains only one for special in the mannetum belance in the same test than ions, and the los spaces in most excelerated alther. If a second ton spaces in promest which does not partitipars in the resistive momentum transfer, ft way he accelerated by the olectric lied while the participating los exparisaces as necessaristic opposites to the field. This mechanism may be applied to the survey in the pagent lief. Significant restativity between the suggest liefs, significant restativity between the suggest liefs. Significant restativity and the provided that the resistivity has the appropriate characteristics. We have used an excelsional survey in the survey of the J. Caephys. Res., A. Paper CAD764

Particles and Fields— Magnetosphere

1720 iscornations between spins wind and mappeterplate RUBSTON STREET ON THE PLANMA SERRY ING COSPOSITION OF MARKE 22, 1979 (CRAN-6) Wilsowartenen (Lochbeed Pain Alto Respark is besteld. 121 linearer Strant, Polo Alia, GA 91987), R. B. Sarr and S. D. Zwicki Both ireo the Please Composition Zapartenet on 1824, needing the onersy range On-1-15 baylo, show that a creening the onersy range On-1-15 baylo, show that a dresails then one numerion with the assential sobrious composition in conjunction with the assential sobrious composition in conjunction with the assential sobre 124 if the appearant to be predefined in the 1825-r incetion rhanged from whit appearant to be predefined to the soir wind to a sixture of composition auchors shout 90-911 of his terestrial inns.

appeared to be predeminantly lass from the all all are all all and a mixture of comporable sumbers of sales wind and transcript lass.

Prior to the substorm entifying about 90-91 of the fee density was due to if and in long. The 0 and is components, each approximately a transcript of the feet of density was due to if and in long. The 0 and is components, each approximately a transcript of the feet o

J. Osophys. Res., A, Paper 4A0568

Sfill inheractions between sater wind and asystematic targets. Services services and and asystematic targets. Services and the services are services as the services and the services are services. Services as the services are services as the services are services as the services are services. Services are services as the services are services as the services are services. Services as the services are services as the services are services as the services are services. Services are services as the services are services as the services are services. Services are services as the services are services are services. Services are services as the services are services as the services are services and services are services. Services are services are services are services as the services are services. Services are services are services are services as the services are services as the services are services. Services are services are services as the services are services. Services are services are se

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7/20 Intersections Potwern sotar wind and magnetosphare Distor Evidence Fos Solik Wino Cowroom. Of JUTITE'S HECTOWITE MAYELWOYN EACHS EXISSION R. D. RESCH NAKE/MONDER STATE FIRST BEATON Observations of the soiar wind close to Jupiner, by the Yoyage T and Yoyage T spanocraft to 1978 and 1970, are compared with the heatcester-wevelength redictions from the pinnet. A significant positive correlation is found before variations to the sotar wind plasma december 4 Jupiner and the level of Jovien radio action output. During the 173-day leterast studied for the Yoyage Z date, the radio actain displayed a long-term pertadicity of about 13 days, identified to that shown by the actor sind desaity at Jupiter sed consistent what the asympton cector estructure assentation thready proposed for groundpased observations of the december-wavelength onleadon. Liupher, radio colonion, Yoyager, saier windi.

J. daophys. Res., A, Paper CASO26

5720 Lateraction between Boler vied Ged Regretosphero INTERPLANETERY PRODUCTOR DIELD CONTROL OF HIGH-LATETUDE ELECTRIC FIELDS AND CURRENTS DETERMINED FROM GREENLAND

INTERLARETERY MEDICATE PIELD CONTROL OF MICH-LATTUNE FIFTHE FIELDS AND CHREENTS DETERMINED FROM GERMLAND MEDICATER PIELDS AND CHREENTS DETERMINED FROM GERMLAND REPETATE PATA.

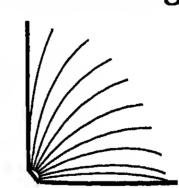
E. Fris-Christensen Division of Goophysics, Danish Metacorologirat Institute, Lyngbyre; 160, Da-2100 Copanisass, Danmark.

I. Resido, A.D. Richaced, S. Mataushta
To daternina the effacts of the inherptesetary magnatic field (1947) on the electric potential as well as on loospherts and field-milgned currents, a recently systiche superical atgorithm is applied to an expirical model of high-tattude magnetic perturbations, parameharised is heren of the Sy- and By-composents of the 1947. The calculated remute reproduce fairty well overalt feature of the influence of the 1947 on high-lattude electric fields which have been reported on the basis of zero of the timeson of high-intitude currents must be polar cusp, which has been shown to dapend strongly on By, extein independently of the syntem of region t and region 2 itsid-aligned currents, which, on the other hand, depends atrongly on By. The direction of the fistid-aligned currents in the dayside polar cap is uniquely controlled by the mign of the By toopwest of has INT, meetly upward currents for SyO in the seyteb boundary of the point cap the SFI Monopheric dudi current ju pandicked between the polar cap field-aligned currents and as oppositely directed for ByO. At the dayside polar cusp and dopositizely directed for ByO. At the dayside boundary of the point cap the SFI Monopheric dudi current sheet on the equatorward aide. For ByOs and By assail the ionospheric and field-aligned currents are localized near the advancement. Whe secont the distribution of field-aligned currents condinated the region is current system and an additional pair of appositely directed currents located poleward of the region is current special coated poleward of the region is current and and an additional pair of appositely field-aligned currents.

5116 Ragnetic fell
508RCES FOR FREREGITC 1085 AT THE PLASMASHEEL BOUNGARY:
11WC YARYING OR STEADY STATE?
D. J. Milliant 17ha Johns Hoprinc University Opplind
flysics 1400ratory, taural, Maryland 261611,
f. W. Spaltor

f. W. Spaltor doulysts of energetic ians observed at the places-thest boundary usually have assumed or interned the oristeness of aither a time verying or a steady that borce. Secause these entumptions are both important and conflicting, we have introstiquated the eniquenest

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Per field stigned or "jetting" (7.5 = 1] as a result of travaring the REL. In general, shellfilload "convention is appected to the layer. The observable signatures of 1600 REN's depend on 7 (countery condition) persecutives of (11 the sens density, 12-31; the total morest and transverse components of the angestic field and fitude whoolty, (61; the agest cheusen the locident transportion of the signature of 12-31; the steep of the sense of the layer and sense through the layer are not sense of the sense of the sense of the Accordingly, the last of observed spaced increases through the layer are not sense of the sense of th

ST75 Trapped particles
YEZ CRAROX STCTA COMPOSTYIOS OF 0. h Nev NELIUM TONS to
SCTTH'S COYER RADIATION BELYS DUPING CHIST TIMES
P. I. Cheestes, J. S. Biske and J. P. Fancell ISpace
Sciacose Imborstory, The Ascropace Corporation, P.O.
Jos 92957, los Cageles, CC 909097
We present ownermagnsts of the oberge state of
9.40-9.55 NeV bellwm lose in serb's outer
mageatosphers il. 5 justing a serei tambelque. The
radial gradient of the bellum ion flum and the
seat-weel smisstropy in the Fitch-angle distribution
are both ensured. These are combtoed with
ownermowness of the gagnetic field to catculate the
flux-weighfed average too gyroradion. Stace the
magnetude of the magnetic field and the seargles of
the toms are shoom, the gyroradica determines the
ton's obarge mets. During two pairs of gaseagneticmity galat days in 1979 as field that so at of these
ions are singly charged. This result is in second
with theoraticut autowistions which first that charge
ownhange reactions between these ions and the mutrel
hydrogen generous are the domisent factor in
condition they the charge state of these
longer these admy other their imjection. Our results
also auguset that the seen charge state of these
hetter lose my very stip position in the magnetosphere and with time. | | | | | | | | | | |
| J. Geophys. Res., A. 7 aper 4480 | |

J. Geophys. Ros., A. Vaper 4A6011

5140 Wave propagation A RECONCILIATION SP PROPAGATION MODES OF CURORAL SILO-

METRIC Sapiation

8. Rashleoto (Department of Electrical Engineering, Kyota University, Systo 606, Japan The propagation modes of AFF are theoretically loves— The propagation modes of AFF are theoretically lovestigated by three-debaustocal ray tracing uring an electron density model based on the sureral playes cavity, such S-X mode and t-9 mode observations are explained in a topsistent manner. The following assumptions are used for the ray tracing, which are superious user the mouse. If The redistion is gumerated in Poth S-X and L-O modes. If A range of ratios of the area frequency to the S-X mode mutoff frequency ff. Is from 1.01 to 1.1. If AFF waves are generated at Uses normal angles shout perpendicular to the geomagnetic field. If AFF is a generated to the sureral planes cavity slong a sightelde field lisa with an invariant latitude of JO². L-O mode waves. Observed observative modes registed the S-X mode waves. Observed observatives and title of AFF can be well as plained moder the following two modifications are measurables. If The S-X mode is stronger than the t-O mode. If Predominantly up-gning waves are generated at the source. The S-X mode is stronger than the t-O mode. If Predominantly up-gning waves campet reach because it is stronger. The L-O mode is racelved to lower intirudes where the S-X mode areas cannot can be absenced. The present interpretation consistently applain the relative of their observed path and a reflection are resonationed. The present interpretation consistently applain the relative of their observed Path ander. It is eightfied that they observed Path ander. It is eightfied that they observed Path ander. (Associal Filmertic registion, rey tracing, propagation under the planes of the L-O mode.) It is eightfied that they observed Path anders.

We reanalyze the ilou node; proposed by uyitle and flose in whith the compitented flow natureth chrough the pore phase of roct is replaced by a single representative conduit. Although the model is a very simple representation of the complicated pore phase in rock, we find that it provides an adequate simulation of bus the transpart properties very with external pressure. Supressions derived for fluid percentility is and toroution factor t are cophined to give an expression for the mean hydraulta radius of the yore phase. Using this expression, we show that the exponent r in the empirical relationship, as PTT, must fail in the range i C r C 2. Clso, we use the expression for hydraulta radius to entite the track area per unit volume and standard deviation of the hight of the asporties on the microarack serfaces for two granites. You values are in reasonable agreement with other asticates.

J. Geophys. Pse., S. Paper 400654

Planetology

6120 Equations of State SHOCK-Ways Equipment of State USING WIEED-FRAME REGIME DATA

tions thousettai description, modelling).

J. Geophys. Res., A, Paper 486035

J. Geophys. Res., A, Paper 486035

J. D. Souddar (2854/Goddard Space Flight Confer, Lab. for Extraterratival Physics, Greenbart, UP 207711

Flaid signatures in the 850 approximation at rotational discontinutties (80) of finits width catled rotational shear layers [331] are assemined for general rice and agentic generals. Annitional and approximation of the page and fill proper and big-pressure phases by level-out argoments litestress that the field speed cas either gn ep or done spreas mell for a first owned fun. The apsed prefile any or any not he monotonic with the phase of the cagestic rotation depending on the besidency oscillation. The flow valuality may or say set travaring the RSL. In general, atgnificant roomysolic or is especiated to the layer. The observable signatures of 1600 RSL's depend on 7 (boundary condition) persectarer (f) the seas density, [2-5]) the locional norest and fill pressure phase Buggolot data. Sur values for persectary, (6); the august of being field and fill values of the august of the signation morest and (fill the size of the magnetic relief and fill values of the signature and (fill the size of the magnetic relief and fill approximate the size of the magnetic relief and fill approximate the algometration files valuely and the size of the magnetic relief and fill approximate the size of the magnetic relief and fill approximate the size of the magnetic relief and fill approximate the size of the magnetic relief and fill approximate the size of the magnetic relief and fill approximate the size of the size of the magnetic relief and fill approximate the size of th

Seismology

J. Geophys. Res., B, Payer 4P0681

OPOL Body Manus

TOCAL DEPTHS AND SAULY PLANT SOLUTIONS OF EARYSQUAKES
AND ALTER INCLOSES OF the direction
Jean Baragouski (Lamont-Doberty Geological Observatory,
Paltandam, New York 199841). Armbruster, L. Seebor,
and P. Noiser

We have coopered synchetic satemograms with long
pariod body waves for also earthquakes with spicenters
in the Missisyma are to deterains deputs of host and to
improve feult phane solutions. Pocal depths are
shatlow (10-20 bs). Inferred aits meeters are locally
perpendicular to the sountain range; they plungs very
gently (-10") in the sentern sections of the range and
more streeply 1-25" is unscrow sections. Assuring
Indis to be a rigid plare, the redtailty oriented stip
vectors taply that southern Yibet extends at about helf
the rate of underthreating in the Seelays, and
therefore probably at about 5-10 mayly. The shellow
depths and gearls dips of the fault planes, at leaser
for the swents in the seatern beff of the range, are
consistent with coherent underthrunting of the Indian
plars beneath, at least, the lesser Rimsleys. The
steeper dips of fault, planes in the swerthding thrust
plate or simply a steepening of the eain maderrhrusting
case beaesth the Greater Missisys.

J. Geophys. Res., R. Paper 499599

J. Geophys. Res., R. Paper 489599

6THO Explosion interesting?

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5940 Phenomera Rejated to Earlingnate Preditties RECONCION AND GEOLOGICAL EVIDENCE FOR FRACTURING.

1. Geophys. Ian., A. Paper 4A8030

3.65 Fartteles and Finide - Regnetosphere (nhietteen)
TROGRAM, ROULTION OF UNITERE COMPTHIEF A COLD PLASMA
INFECTION EXPERIENT
G. Congult, P. Felmadeases and J. Funder (Record
hassarch taboratory, Stabillagide, S.C. 20375)
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3 - 8 MAVE YESVEL TIME RESIDUALS AND LATERAL
LINGWOODSHIFT IN THE RANTLE BEMEATH TREET AND THE
RICLAYA
P. Moiner (Department of Earth, Divemphatic, and
Finetery Eciances, Hassachusetts Institute of
Technology, Cambridge, HA 021991 and U.-P. Chen
The average S wave travel time residuals from 11
earthquakes each in TiPet and the Histoleya imply that
there are carked lateral variacions in structure beneath
Tibet and the Himsleya. Average S - P wave residuals,
measured with respect to the J-O tables, for sack of it
marthquakes in the Minsleya are less than H s. Average
J-8 3 - 8 residuals from 10 of it earthquakes in Tibet,
however, are greater than H s., even when corrected for
the large crostal thickness of Tibet. The largeac
values, t.im, f.lm, 2.4s, 8.5s, and 4.9s, are for tive
events in central and northern Tibet, and they imply
that the everage velocities in the crust and upper
mantle of these portions of Tibet are 4-10% lower than
those beneath the Histoleys. Therefore, it is unlikely
that a shield structure underlies these parts of Tibet,
unions there t - 8 residuals are due to variations in
effecture deeper than 23P km. S - V residuals tron 7
other sweets each in watern and earrem Tibet are 1 to
t a loca, and hance suggest that relactions hemeath
chase areas are also socaubat lower than beneath
these areas are also socaubat lower than beneath
these close to rhose of the swerage earth toward the
east, south and west, (t - P Seciduals, mentie, Tibet,
etcalsyst.

J. Geophys, Res., 8, Paper 480684

5976 Upps: Mantle Structure
MAFPING THE UPPSE MANTLE: THREE SEMENSIONAL MODELLENG
OF LEATH STRUCTURE BY INVERSION OF REIGHTC SAVEFORMS
John H. Woodboom (Department of Geological Schunges,
Hervard Wolvereity, Csobildgs, NA 021351 and adam H.

John B. Woodboom (Department of Geological Sciences, Hervard Valvereity, Cobildge, RA 021351 and adam M. Delevonski

A untimod is presented for the investion of coverons dars for the three dimensional distribution of medical cover verfocities. The method is applied to date from the global digital untworke (International Deployment of Assistancesters, Ciobal Official Balangraph Natwork); the selected data ser consists of some 2000 secanograms corresponding to 51 events and 570 paths. The moment tensors of the earthquakes are determined through an iteracive procedure which minimizes the corrupting influence of tareard katerogeneity. A global social is constructed for shear wave valocity, expended up so degree and order \$ is sphewical hetsocica, and described by a tubic polymostil is dapth, for the upper \$70 for in the Earth's meetla. Although so a priori loformarian he tancorporated also order produces such of what is known about the disparation of meetla meven, e.g. high phese velocities for absatch, low velocities at ridges, a strong dagree 2 patrent for reproduce such of what is known about the disparation of meetla meven, e.g. high phese velocities for absatch, low velocities at ridges, a strong dagree 2 patrent for meetla meven, e.g. high phese velocities for absatch, low velocities are ridges, a strong dagree 2 patrent for meetla meven, e.g. high phese velocities for absatch, low velocities are the constituted iros aseb half of the soul date ser considered Indepandently. The model shows that the soul tensor that the souls that see such and the series which are southern Pacific and the larger shields partials to 550 tes, but his South Reat Cadles Lies as the series of the southern Pacific and the larger shields partials to 550 tes, but his South Reat Cadles Lies dapth, as is much of the mid-Atlancic ridge. At 435-650 km the mojor features are should region of high velocity anomaly beneath the measurem Facific and a low velocity anomaly beneath the measurem Facific and a low velocity anomaly beneath the measu

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Broadband recentre Twacking developed from teleseisals F-mysforms recented for rerited twolaboratory, F.D. Dee 508, Literarore, G. 19550)
Broadband recentre Twacking residence
in RITH shatton RSCF are inverted for rerited twolocal from the Company of the Company of the Contions of the Company of the Company of the Company
attacking source—equalized horizontal componente of
hateselsain F-waveforms. The recelling rom lyer functions ors most schafflic to the chear miscally structure maps the stackion. & Lime-domain investion roution
utilizes the redial receiver Funchion to determine that the
etracture semaning & crushet model persentantian the
samy this, first-lying, hocogeneous layers. Literal
changes in Struchure are identified by expelsing salawthal yeriations & the vertical atrustors. The recelt
remost algarificant rapid istancionages in the aldocustal Atrusture beneath the shation that are interpreted to relation to the origin of the East-Continent
Sravity Sign, located porthamet of RSCP. The resetts
from sweets scrawing from the northwest show a highmetocity aid-crustal hayer non present in readine from
the derived velocity models in the Indication that the
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the derived velocity models in the Indication that the
crust-ments boundary beneath the Camberland Flatiess is
a thick, probably lemionted, brannition zone haceson
the depths of 80 and 85 km, a result consistent with
interpretations of many refraction, crustal structure,
East-Continues for the set of the set of the conclosure of the set o

J. Saophya. Res., 5, Papar 450685